28 DECEMBER 1956

ONE SHILLING & SIXPENCE

FLIGHT

and

AIRCRAFT ENGINEER

OFFICIAL ORGAN OF THE ROYAL AERO CLUB

Seasonal Greetings for 1957

Blackburn and General Aircraft Limited

Brough East Yorks England

A145

Centrifugal Castings

Firth-Vickers have developed reliable centrifugal casting techniques to ensure that the finished product is best suited to the purpose for which it is made.

Advice based upon a unique fund of experience is readily available.

FIRTH - VICKERS STAINLESS STEELS LTD., SHEFFIELD

TELEPHONE: SHEFFIELD 42051

MORE THAN 90 years behind them..

put OPPERMAN in front!

The 1860's . . . a far cry from the atomic age, jet engines, VHF electronics and automation. That S. E. Opperman has bridged the gap of the century in which mankind's most outstanding advances have been made is manifested in the development and production of engineering products now in use the world over.

These photographs give some idea of the scope of the Opperman factories covering 145,000 square feet. Our extensive resources for the development and manufacture of almost any aircraft, motor, marine, electronic or general engineering product is at *your* disposal. Can we assist you?

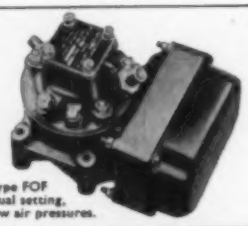
S. E. OPPERMAN LTD.

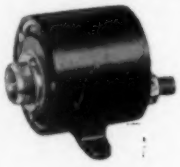
Boreham Wood, Herts. ELSTREE 2021.

Erwood

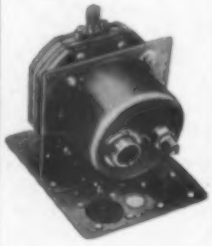
Type PAF
Dual setting, high fuel pressures.

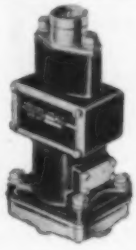
Type PAC Mach Number.


Type FOF
Dual setting,
low air pressures.

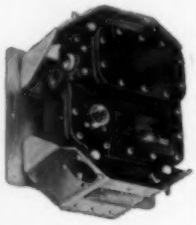

Type PAD Altitude.

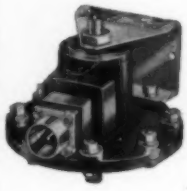
Type FGY Fuel pressure.


Type FKK
Differential air pressure.

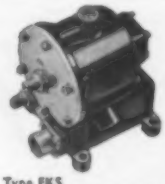

Type FKY
Air and selected liquids.

PRESSURE SWITCHES
for
Every Aircraft Application


Type FLY Pressure ratio.


Type FGW Ram air pressure

TEDDINGTON AIRCRAFT CONTROLS LTD., MERTHYR TYDFIL, SOUTH WALES Telephone: Merthyr Tydfil 666.
London Offices: Colnbrook By-Pass, West Drayton, Middlesex, *Telephone:* Colnbrook 502
51 Brompton Road, S.W.3. *Telephone:* KENsington 4808


Type FKS
Differential fuel pressure.

Type FOM Oil pressure.

Teddington
CONTROLS
REGD. TRADE MARK

Type FKY
Air and selected liquids.

Type FPH Hydraulic pressure.

Quality Products..

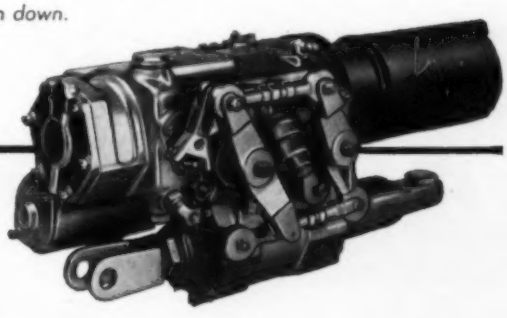
QUENCHING OILS

No. 2 Soluble Quenching Oil stands pre-eminent in providing uniform quenching speed and years of service throughout a wide temperature range.
It remains uniform with continued use and is good to the last drop.
No. 2 Soluble Quenching Oil outlasts other quenching oils and, based on ultimate cost, is the most economical to use.
We have a demonstration heat-treatment plant at our Birmingham works and our metallurgical staff will gladly advise on the selection and best application of our efficiency products.

Edgar Vaughan & Co. Ltd.
BIRMINGHAM · 4 · ENGLAND
Works and Depots at: Birmingham, Manchester, Liverpool, Southall (Middx.), Bristol, Glasgow

PRECISION

In performance, as in construction, Boulton Paul Power Controls are precise. Their response to any movement of the control column is accurate and consistent. With such precision and reliability at his command, the pilot comes to regard his Boulton Paul Power Controls as a staunch friend who will not let him down.



BOULTON PAUL AIRCRAFT LTD.

WOLVERHAMPTON

If it's a difficult non-ferrous casting — consult Birkett, Billington & Newton. On the right is an example of what they can do. It is one of a pair of housings for the driving shaft of an independently sprung wheel. To withstand severe shocks and stresses it was cast in high tensile manganese bronze and then precision-machined.
Birkett, Billington & Newton have the facilities and knowledge to solve your non-ferrous casting problems—however difficult.

What's yours?

CASTINGS FROM A FEW OUNCES TO 10 TONS

in phosphor-bronze, gun-metal, aluminium-bronze, manganese-bronze and light alloys. Precision-machined bushes and bearings. Specialists in high-tensile aluminium bronze castings, centrifugal-cast wheel blanks, and chill-cast rods and tubes.

BIRSO TRADE MARK BN

One of Britain's Largest
NON-FERROUS
Foundries

T. M. BIRKETT, BILLINGTON & NEWTON LTD
HANLEY AND LONGPORT, STOKE-ON-TRENT
Head Office: HANLEY, Phone: Stoke-on-Trent 22184/5/6/7. LONGPORT, Phone: Stoke-on-Trent 87303

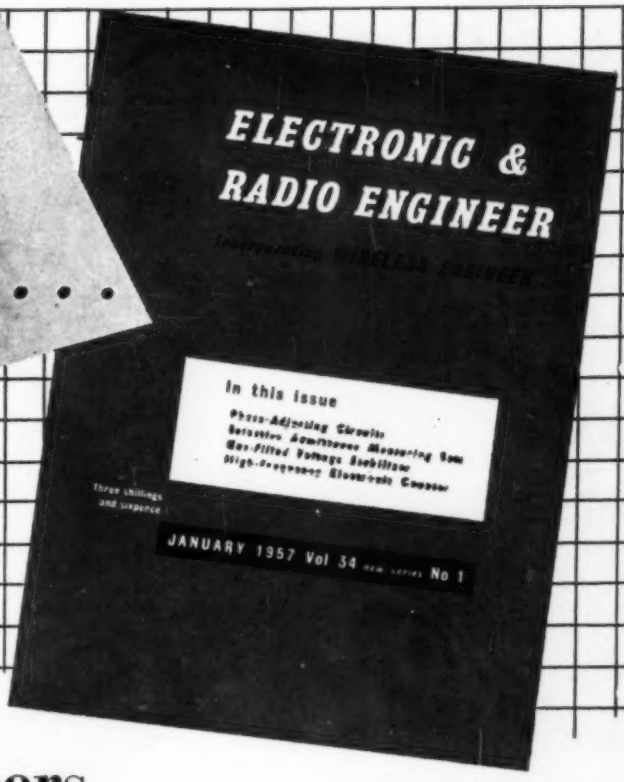
FOR FAST NUMBERS...

There's safety in numbers (mach numbers, that is) for speed merchants who specify Triplex. Take Triplex toughened glass, for instance, withstands anything up to 250°C — and still enables the pilot to see where he's going.

Fit "TripleX" and Be Safe

TRIPLEX SAFETY GLASS CO. LTD., 1 ALBEMARLE STREET, PICCADILLY, LONDON, W.1
T.A.12

WIRELESS ENGINEER *becomes . . .*



Important news for electronic engineers

For 33 years WIRELESS ENGINEER has served the world's leading engineers, designers and technicians, publishing original work of eminent physicists and research engineers. Now, under the new title of ELECTRONIC AND RADIO ENGINEER, and with a 40 per cent increase in content, its influence has been extended to include information of *more immediate application* in both electronics and radio. With the continued support of an advisory board representing Universities, the D.S.I.R., the B.B.C. and the Post Office, and with an enlarged abstracts section, the new ELECTRONIC & RADIO ENGINEER will prove indispensable to all concerned with design, development, production and industrial application of electronic and radio apparatus. To be certain of beginning your readership with the first issue—out January 5—complete the coupon TODAY.

A representative selection from the contents of the January and subsequent issues.

PHASE-ADJUSTING CIRCUITS: A review of the chracteristics of simple-type phase-adjusting circuits.

SELECTIVE ADMITTANCE MEASURING SET: Specifically for measurement of aerial admittance, but of general application wherever measurements must be made under conditions of interference.

GAS-FILLED VOLTAGE STABILIZERS: The results of a series of measurements in tubes.

NON-LINEAR CIRCUIT EQUATIONS: Solution of some non-linear problems.

TRANSISTOR PULSE GENERATOR: A simple generator using complementary transitors.

CALCULATION OF CAPACITANCE: Geometrical method of computing capacitance.

STANDARDIZATION OF CIRCUITS: A critical review of an American National Bureau of Standards publication.

SOLENOIDS FOR AIRBORNE APPLICATIONS: Designing magnet coils for minimum total weight taking into account the effective weight of the power supply.

POST THIS COUPON TODAY

TO ILIFFE & SONS, LTD., DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1.

☐ Please enter my subscription for 1 year (12 issues) to ELECTRONIC AND RADIO ENGINEER. Remittance value £2 9s. enclosed.

☐ Please send me a specimen copy of ELECTRONIC & RADIO ENGINEER.

Signed .....

Address .....

Overseas Readers. Take advantage of our introductory offer of 3 years' subscription for the price of 2. Remit £4 18s. 0d. by International Money Order or Banker's Draft today.

ELECTRONIC & RADIO ENGINEER

incorporating WIRELESS ENGINEER

SAFE AS SAUNDERS

For fuels, oils, water, hot and cold air, rocket fluids, nitrogen, hydraulic and de-icing fluids and the many other operational fluids encountered in modern aviation.

SAUNDERS AEROS VALVES

To ensure the most suitable type for your purpose discuss the subject with the makers.

SAUNDERS VALVE CO. LTD.
Aircraft Division
BLACKFRIARS STREET, HEREFORD

AIR SPEED CALIBRATOR 1A190
MARK IIC

NEW DESIGN

For airspeeds up to 800 knots

Scale reading in knots and in M.M. water

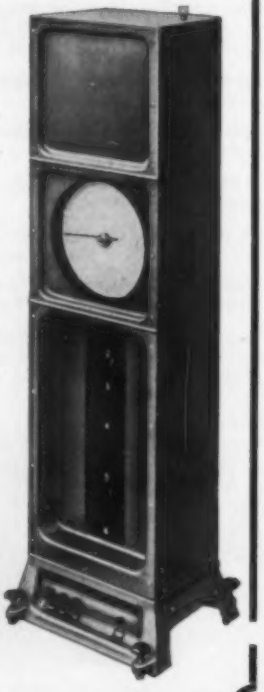
Used by the aircraft industry and service departments

The new high-range calibrator

Approved by the Air Ministry

Extended scale of 148 inches

Mercury operated



Telephone : Enterprise 4422

R. W. MUNRO LIMITED
BOUNDS GREEN
LONDON, N.11

Outstanding FLIGHT publication

"Each picture is worth framing"

Intoravia

10½ins × 12½ins 24 plates

7s. 6d. net.

By post 8s. 5d.

FLIGHT FLY-PAST

A Portfolio of aircraft photographs by "Flight" cameramen, whose work is prized by enthusiasts throughout the world. This attractive portfolio contains an outstanding selection of their recent work, superbly reproduced, and includes photographs taken at S.B.A.C. Air Display at Farnborough, September, 1955.

Obtainable from booksellers, or from:—

"Flight", Dorset House, Stamford Street, London S.E.1

Aircraft Furnishing

- PASSENGER & CREW SEATING
- UPHOLSTERY & LOOSE COVERS
- FOAM RUBBER & MOULDED HAIR FILLINGS
- FLOOR COVERINGS—TEXTILE EQUIPMENT
- "KARGO-PAK" FREIGHT CONTAINER
- PASSENGER SAFETY BELTS

Unequalled Facilities for Repairs & Renovations

LATEX UPHOLSTERY LTD.
THE LEADING SPECIALISTS
41, LONSDALE ROAD, LONDON, W.11
TELEPHONE BAYSWATER 6262/5

WILSON

OF LONDON

for

Aluminium

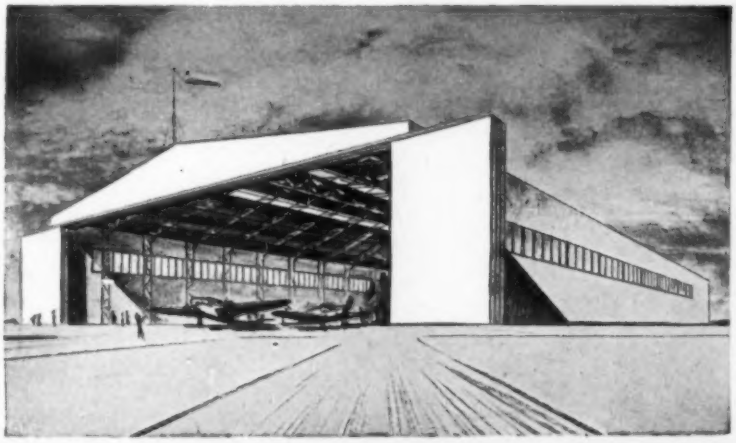
and

Alloys

A·I·D & A·R·B
APPROVED STOCKISTS

W · WILSON & SONS (LONDON) LTD

Registered Office and Works
114 Nightingale Road London N.22
Tel. BOWes Park 8431/6



Standard designs
200′ 0″ to 30′ 0″ spans

STEEL ECONOMY
SPACE ECONOMY

TROPICAL SHEDS & HOUSES
GODOWNS · BARRACKS · OFFICES, ETC.

We supply and erect in any part of the world.

GENERAL UTILITY **STEEL BUILDINGS** AND **HANGARS**

FOR HIRE. Erection masts 30ft. to 120ft. high. Cranes and lifting tackle.

BELLMAN HANGARS

LIMITED

HOBART HOUSE, GROSVENOR PLACE, LONDON, S.W.1 *Tel:* **SLOANE 5258** *Cables: Unitstruct, Sowest*

ROTOL
TCA

FIRST AERONAUTICAL WEEKLY IN THE WORLD FOUNDED 1909

FLIGHT and AIRCRAFT ENGINEER

No 2501 Vol 70 FRIDAY 28 DECEMBER 1956

Editor
MAURICE A. SMITH D.F.C. and BAR

Associate Editor
H. F. KING M.B.E.

Technical Editor
W. T. GUNSTON

Production Editor
ROY CASEY

Iliffe and Sons Ltd
Dorset House
Stamford Street
London, S.E.1
Telephone · Waterloo 3333 (60 lines)

BRANCH OFFICES

Coventry
8-10 Corporation Street
Telephone · Coventry 5210

Birmingham 2
King Edward House, New Street
Telephone · Midland 7191 (7 lines)

Manchester 3
260 Deansgate
Telephone · Blackfriars 4412 (3 lines)
Deansgate 3595 (2 lines)

Glasgow C.2
26B Renfield Street
Telephone · Central 1265 (2 lines)

Toronto 1, Ontario
Thomas Skinner and Co., Ltd.
67 Yonge Street
Telephone · Empire 6-0873

New York 6, N.Y.
111 Broadway
Telephone · Digby 9-1197

SUBSCRIPTION RATES
Home and Overseas · Twelve Months, £4 10s. U.S.A. and Canada, $14.00

In this issue

982 Air *versus* Rail
983 Point Cook's Proud Day
985 Keeping Heat in its Place
987 Test of Friendship
992 The N.A.C.A. Langley Aeronautical Laboratory
994 Research, Development and Technical Issues
998 Talking about Rockets
999 The Short Seaplanes—Part 3

Ambassador Extraordinary

IF ever the grossly overworked term "classic" could justly be applied to a technical dissertation, then it is certainly merited by Sir Arnold Hall's 1956 Wright Brothers Lecture, delivered recently in Washington. The first part appears in this issue. Lofty in stature and firmly based on authority and sagacity, it soars above the massive (some would say oppressive) documentation which is so much a part of the aeronautical scene.

We read (in Part II) of the by-pass and ducted-fan gas turbine engines—the latter now making a last, and strong, bid for acceptance in the propulsion of high subsonic long-range transports; of the supersonic tailless delta, exemplified by the Fairey F.D.2 (so much more than simply a very fast aeroplane); the jet-lift scheme—and particularly the narrow-delta v.t.o. proposal by Dr. Griffiths of Rolls-Royce; the arrangement known as the jet flap, which offers a method of improving runway performance of a far more radical kind than "flap blowing," though short of full v.t.o.; and Mr. Greatrex's contributions to noise suppression.

All these British advances will be achieved with the aid of mounting technical resources, whereas (and Sir Arnold did not fail to remind his New World audience of the fact) the present generation had to be developed "without as much benefit as we would have liked from the technical resources which are recognized to be such an immense help in achieving performance and in reducing the time of development." Then, seizing his opportunity further, he added: "The critics of the British industry, both at home and abroad—and there have been some in the U.S.A.—have perhaps forgotten that notwithstanding these difficulties the present generation of British aircraft and engines are as good as, or better than, their competitors to the extent that the world outside Britain is buying them at the rate of 300 million dollars' worth a year."

It might be argued that the auditorium of a learned society is not a clearing house for national propaganda. But precedents are plentiful; and, for our own part, we applaud the manner in which this distinguished British scientist apprised his listeners of some of the facts of business life as well as illuminating their view of the technical scene.

The Auxiliary Squadrons

ONCE again the sword of Damocles hangs over the fighter squadrons of the Royal Auxiliary Air Force; rumours concerning their coming disbandment are widely current. But whereas there are 20 fighter squadrons, there are many more Auxiliary Fighter Control Units, and Field Squadrons of the Royal Auxiliary Air Force Regiment, whose existence does not at the moment appear to be threatened.

The Auxiliary flying units will themselves strongly resist any move towards disbandment, partly because they are proud of the spirit and enthusiasm of a volunteer force such as theirs, and partly because they know that they represent an important proportion of the country's air defence strength. There are alternatives to disbandment—a weeding out of the less effective squadrons, or a change of rôle—which the authorities are doubtless considering carefully. Attachment to regular squadrons, or formation of composite regular and Auxiliary units, could hardly be satisfactory.

But whatever the pros and cons it is clear that the sword of disbandment, should it fall, will do so solely because its restraining thread has become too expensive. If an official announcement gives this explanation the Auxiliaries will accept it with a good grace; but if their supposed inability to handle modern fighters—already disproved in practice—is put forward by politicians (as it was last year) then the blow will be bitterly resented. If stand down they must, the men of the R.Aux.A.F. should be allowed to do so in the knowledge that their country is grateful for all they have done since 1925; that the time—and lives—they have freely given to her defence are not forgotten.

THE STAR-SPANGLED MANNER: For comparison with the picture opposite we print this newly received impression of the Thunderbirds —the U.S.A.F. Precision Flying Team— on North American F-100C Super Sabres.

FROM ALL QUARTERS

B-47s' Eight-million-mile Fortnight

IT was disclosed on December 18 that during a two-week period up to that date over a thousand B-47s, using aerial refuelling, had flown non-stop missions averaging 8,000 miles each. General Nathan Twining, the U.S.A.F. Chief of Staff, said it was the first time the strategic air force had tested the operational capability of its strike force in such large numbers during such a short period of time.

In an address prepared for delivery to cadets of the Air Force Academy, Gen. Twining cited the programme as a "dramatic example" of deterrent air-power, demonstrating the United States' ability to launch a retaliatory strike force in minimum time.

The General noted that just before the B-47 flights the Strategic Air Command had demonstrated the potentiality of the B-52 by simulated combat missions on which they stayed up more than 24 hr and flew as far as 17,000 miles. The flights of the B-47s were described as being "over the North American Continent and the Arctic regions." Gen. Twining did not disclose specific routes or the bases from which the thousand aircraft operated.

René Couzinet

FROM Paris comes news of the death—in tragic circumstances—of the French aircraft designer René Couzinet. Particularly in pre-war years he had been responsible for the design of a number of notable aircraft, including the three-engined *Arc-en-Ciel*, which was the first machine to fly the South Atlantic in both directions.

Rapid Rebasing

ON December 13 a Swedish Air Force squadron of Hunters flew from Gothenburg to Stockholm, a distance of 250 miles, in 19 min 45 sec. Flying at 32,000ft, and assisted by strong tail winds, they achieved an average ground speed of nearly 760 m.p.h.

The nine Hunters, which were "rebasing" from Fighter Wing F.9 to F.18, were led by S/L. K. E. von Heland. A Hawker Siddeley Group spokesman said that the aircraft had been built at the Hawker factories at Kingston-on-Thames and were part of a delivery order for the Swedish Air Force.

The Great Hercules Chase

POSSIBLY stimulated by the Walt Disney film *The Great Locomotive Chase*, in which Marietta, Georgia, figures with some prominence, a Lockheed C-130 Hercules has flown to that city from Ardmore, Oklahoma—a distance of 736 miles—at an average of 423 m.p.h. It was, of course, aided by a tail wind and, flying at 27,000ft, it exceeded 500 m.p.h. ground speed at one period. A second Hercules completed the same trip in only five minutes longer flying time.

New Migs for Nasser?

EARLIER this month Col. Nasser made a curious reference to Russian-built fighters in Egypt, during an interview with a correspondent of *Time* magazine.

He claimed that the Egyptian Air Force had been equipped with a number of "twin-jet Mig-17s," some of which, he said, had taken refuge in Syria during the Allied bombing attacks. He went on: "Nobody knew we had any Mig-17s until one day early in the fighting when three of them were surprised near an airfield in the Canal Zone. The Migs turned, shot down three Mystères and drove off five others with no losses. After enemy forces withdraw from our territory we shall have many stories to tell." He also commented on the fact that Anglo-French bombing prevented the E.A.F. from supporting his troops in the Sinai Desert.

In fact, of course, the Mig-17 is a single-engined fighter powered by an engine basically similar to the Rolls-Royce Tay. The much more advanced, supersonic Mig-19 is twin-engined and it is just conceivable that a number of these fine machines may have been supplied to Egypt, though none has been identified in that area.

A Notable Flying Film

IT is typical of Hollywood that it will go to the trouble and expense of making a first-class film for general showing on some phase of technical development that has never before been fully illustrated. Also typically, it will hang a series of superb coloured aerial photographic sequences on a "human drama" full of those emotional complexes apparently inseparable from the American way of life. A new Warner Brothers film, *Brink of Hell*, in colour and wide screen, is true to this tradition; aeronautically it ranks with such fine efforts as *The Bridges of Toko Ri* and *Threshold of Space*.

As the subtitles unfurl, one tries vainly to watch, past names of hair-stylists and costume designers, the afterburning take-off of an F-102A into a splendid sunset. Thereafter the plot unfolds against the background of Edwards Air Force Base, fairly teeming with the latest research and operational aircraft—in the flesh. It concerns the struggle of U.S.A.F. Maj. Lincoln Bond (William Holden), who has been tortured into signing a germ-warfare confession in Korea, to regain both his own and his superiors' confidence in himself. He finds a structural weakness in the "new" XF-120 (Martin B-51 prototype). Followed by an F-100 "chase plane," he is seen rolling and diving through the sunny air over the Mojave Desert in sequences which are some of the best yet. There follows a psychological interval while love and confidence are sorted out between gallant major, glamorous secretary (Virginia Leith) and commanding general (Lloyd Nolan).

Confidence being partly established, Bond and the general go up in two F-94Cs to stream a drag parachute at 20,000ft. The parachute hangs up and the general dives helplessly earthwards. Bond then closes in and picks up the parachute on his tip-tank. Though the sequence could have been done by "special effects" in the studio, the real thing was photographed; and the two F-94Cs are seen landing in close formation on the desert, one holding the other's drag chute. This is dramatic.

There follows more psychology and friction, both romantic and professional. Finally Bond makes the psychological grade and is assigned to test the Bell X-2. And here we see the whole sequence of X-2 loading, fuelling, take-off and launching under the B-29 mother-ship—much of it, clearly, from the official records of the development tests. The whole operation is shown in close detail, followed by air-to-air shots of the X-2 making its dead-stick landing. Then the X-2 has to be jettisoned and explodes a second after the pressure-suited pilot is dragged back into the B-29. Bond finishes with an unauthorized full-power run in the X-2 and meets inertia coupling—just as "Chuck" Yeager did in the X-1. Bond bales out; Yeager, it will be remembered, could not, but had to ride the aircraft down.

Brink of Hell is now showing at the Warner Theatre, London.

Formation aerobatics in the grand style are demonstrated above by the 2nd T.A.F. aerobatic team. The vic is composed of five Hawker Hunter F.4s of No. 93 Squadron, and the "box" machine is a Hunter of the same mark from No. 118 Squadron. The pilot of the latter is F/L. Ken Goodwin, whose speciality is a solo act; the No. 93 Squadron pilots are seen and named below.

2nd T.A.F. AEROBATICS

The No. 93 Squadron element of the 2nd T.A.F. aerobatic team: (left to right) F/O. W. Clayton-Jones (reserve); F/O. D. S. Chadwick (No. 2); S/L. D. F. M. Browne, A.F.C. (leader); F/O. B. A. E. Sanderson (No. 4); and F/O. D. Exley (No. 3).

Orion's First Thousand

DURING the twelve months following its first test run on December 10 last year, the Bristol Orion two-spool turboprop has completed over 1,000 hours' development testing, more than 50 hr of this being by engines installed in a Britannia.

This recent announcement by Bristol Aero-Engines, Ltd., of the Orion's encouraging start goes on to state that the new combined U.S./U.K. type test schedule, which is more severe than the older 150-hr schedule, has been used during development running. From the outset, the Orion was designed as a complete powerplant, embodying cowling, oil tank, oil coolers and engine mountings, and all running of the engine has been carried out in this form, with a de Havilland propeller.

To clear engines for flight, 25-hr special-category tests were completed, and the Orion was flown for the first time in the Britannia prototype G-ALBO (now being used as an engine test-bed) on August 31. In this form—with the Orion as port outer, a Proteus 755 as starboard outer, and Proteus 705 inboards—the Orion was given its first public showing in G-ALBO at this year's Farnborough.

Preliminary design work on the Orion began in 1952. Since then, detail design and manufacture have made rapid progress. Six prototype engines have been built—four for bench running and two for flight—and a seventh is now being manufactured. One of the six engines has completed more than 400 hours' running without being removed from the test-bed, including 111 hr non-stop. During development testing the full design power—5,150 e.h.p. for the Orion 1—has been achieved.

The Orion was described in detail in *Flight* of October 26.

U.S. Racing Pilots Confer

AT the Professional Race Pilots Association national convention, held recently at Cleveland, Ohio, a plan to hold races just off the shore-line of large lakes was considered. This, it was felt, would eliminate danger to spectators and property and give an improved grandstand view. The safety factor has prompted Cleveland (on Lake Erie)—where the "Nationals" have not been held since 1949—to negotiate for the return of them in 1959.

The new president of the P.R.P.A. is Bill Falck, who holds the short-course lap record for small aircraft (208.81 m.p.h.).

AIR *versus* RAIL

—*for Internal Routes from London: the Problem of Overall Journey-time*

THE recent increases in United Kingdom internal air route fares raise once more the perennial question whether short-stage passenger air transport, say, up to 300 nautical miles, can effectively and profitably be operated to and from London.

The advent of aircraft with satisfactory short-range economics undoubtedly enables this question to be answered with a conditional affirmative, the condition being that sufficient passengers are forthcoming to fill most of the seats. Only on a few such services is this condition properly fulfilled at present. Why is this, and what can be done to remedy the situation?

The first consideration from the point of view of the large majority of potential air passengers is the saving of time which they hope to achieve. Although, in the past, flights have been cancelled or delayed by bad weather, the art or science of flying in these conditions is advancing to a stage where they are ceasing to be a major impediment to operations. A far bigger (and as yet unsolved) problem is the delay in getting passengers quickly from city centres to airports and *vice versa*. Because their development is a matter of comparatively recent history and because they need so much space, airports are nearly always to be found on the distant outskirts of the cities they are intended to serve. As a result, they compare badly with the longer-established railways, whose terminal stations are usually adjacent to the city centres; air passengers often waste more time in transport between city terminals and airports than they save while in the air. It is not the slightest use flying in a modern aircraft with a cruising speed of the order of 300 knots if the overall average speed between city terminals is going to be reduced to under 50 kt as a result of having to spend several hours in airport buses and in transferring between them and the aircraft. The simple graph below illustrates this situation.

At present, a passenger travelling on British internal air services spends some three hours in buses or in transferring between aircraft and buses. This period is not affected by the length of the journey and therefore has a particularly adverse effect on average speed between city terminals in the case of the shorter stages. Thus an air passenger for Birmingham, starting from London at the same time as a colleague going by rail, may not have taken off from London Airport by the time the latter is steaming into Birmingham Station. It is only at Manchester that he would stand a chance of catching him up. This is a fantastic situation. How can anybody be expected to pay more for a slower journey and even then with less certainty of keeping to schedule? He will normally save time only if the flight is to Edinburgh, Glasgow, or to a place separated from London by a sea gap.

It would be unwise to assume that the railways, now being modernized, will do no better than maintain their present rather uninspiring schedules. It would be reasonable to expect that the existing average express speeds of around 50 kt will be raised to at least 75 kt, bearing in mind that some pre-war trains reached over 100 kt on some stretches. In this case the rail traveller will keep up with his airborne friend as far even as Edinburgh and Glasgow. Internal air services between places also connected by a direct rail link will become dead mutton—unless. . . .

One approach would be to reduce air fares to the level of corresponding rail fares; but even if this solution were economically feasible it remains somewhat defeatist. The aim must surely be to exploit the speed of flight and to do this the time-wasting surface transport problem must be solved. There are two possible lines of attack: (1) to effect a drastic speed-up in surface transport and passenger handling; (2) to discard both surface transport and the conventional aircraft and develop the helicopter for direct services between city centres.

Taking the first of these alternatives, the question of rapid passenger-handling is simply a matter of good organization backed by time-and-motion study; the main problem is how to shorten surface transport times.

Air traffic is now reaching a state of near saturation at London and other airports, so it would seem that a solution based on the use of helicopters for transport between airport and city terminal is unlikely to find favour now, and still less in the future. Besides, this is a basically clumsy approach. A rail or underground extension from the nearest line to the airport would effect an appreciable saving of time, perhaps from three hours to two if in operation at both ends of the flight. The present train to Birmingham would still beat the air service, however, and a 75-kt train would also beat it to Manchester and other towns at a similar distance. The best hope appears to reside in the monorail*; if this system operated at both ends of the journey it might just be possible to cut the total time spent by passengers on the ground to one hour. Even then, however, there would be no saving in comparison with the 75-kt train for journeys of less than 120 nautical miles.

It is hard to escape the conclusion that even with monorail links at both ends of the flight it is only for journeys to Glasgow and Edinburgh, or across a water gap, that the air passenger will save sufficient time to justify the extra cost of his fare. (One small reservation occurs in the case of a passenger arriving at London by air and subsequently proceeding by air to another destination.)

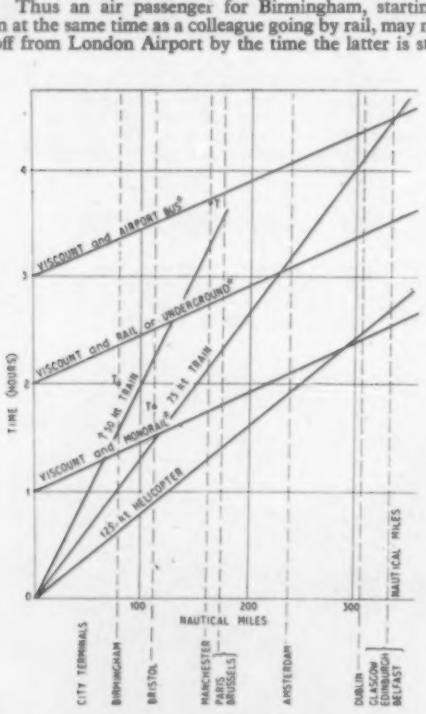
There remains the second alternative—the direct inter-city centre helicopter service. Referring once more to the graph it will be seen that a helicopter averaging 125 kt will beat the Viscount-plus-monorail combination over all distances under 300 nautical miles. The objections to the helicopter are:—

(1) A present lack of suitable aircraft. (This should be remedied in the course of the next five years.)
(2) Greater initial and operational costs in comparison with fixed-wing aircraft. (There is reason to hope that for stages under 300 n.m. these may be cut within a few years to a competitive level.)
(3) Objections by citizens to the noise and possible hazards of helicopter operations into built-up city areas. (It is probable that these can be satisfactorily met.)

Thus the eventual prospects for large-scale internal air services in the U.K. may well come to depend on the fast helicopter, fixed-wing services being retained only from London to Edinburgh, Glasgow, Belfast, Dublin and to distant destinations on the Continent.

The acceptance of the helicopter carries important implications with regard to London's airport requirements. It has recently been suggested that London Airport and Gatwick together will not, in the fairly near future, be able to cater for the ever-growing traffic and that a further airport on the Northern outskirts of London will be needed. If, however, the bulk of internal air traffic is to be carried by helicopter, it would seem that London's third air terminal should be a helicopter station near the city centre. If this possibility is not borne in mind there is likely to be a waste of many millions of the taxpayers' money in providing the wrong kind of terminal in the wrong place.

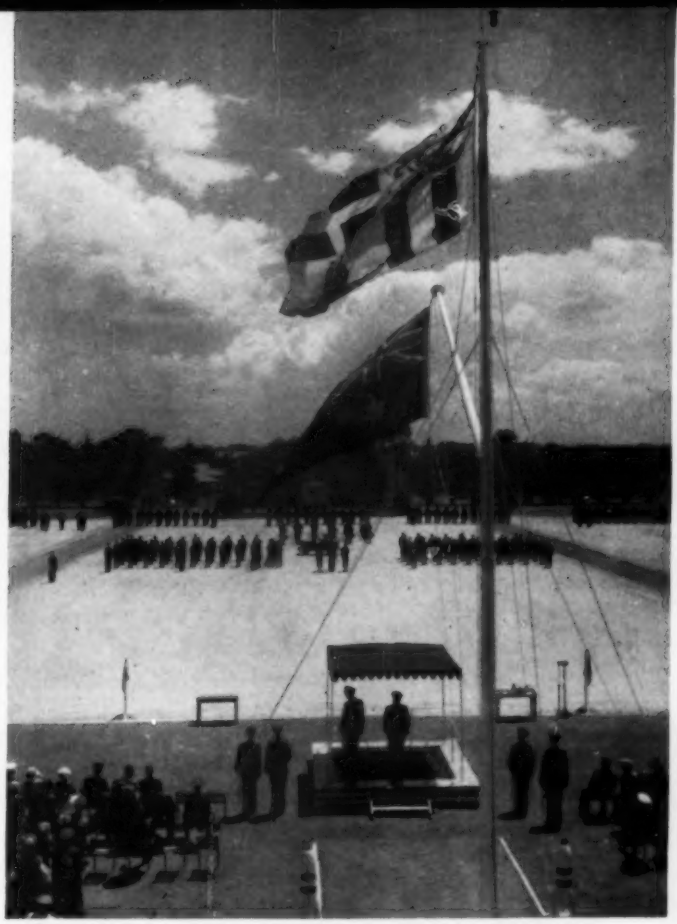
INTEGRATOR.



* Includes transit times between both city terminals and their airports and transfer times between aircraft and surface transport.
† In most cases no appreciable error occurs if distances along air routes are assumed to be the same as distances by rail.
T indicates actual present time of arrival of train.

Outward from London: the author's simple air v. rail analysis.

**A transport system in which a high-speed car is suspended from a single overhead rail carried on a series of gantries. It has frequently been proposed as a link between London and London Airport, with the gantries spanning existing highways—Ed.*



Point Cook's Proud Day

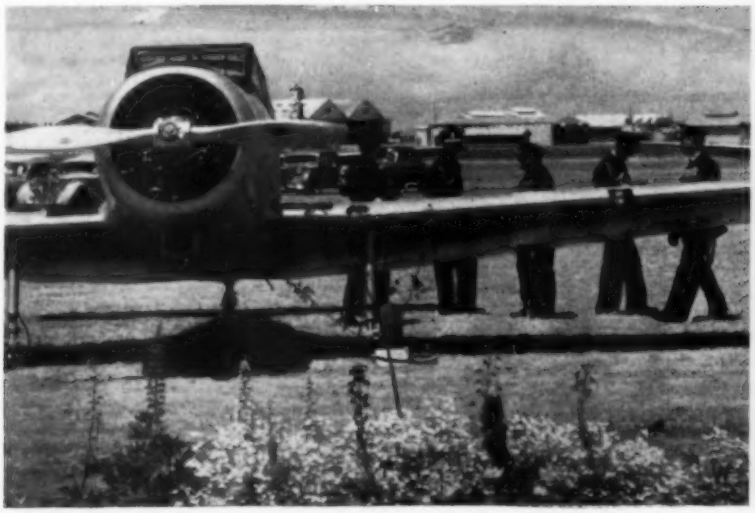
SUNSHINE, ceremonial, and royalty—in the person of the Duke of Edinburgh, wearing the uniform of a Marshal of the Royal Australian Air Force—marked the graduation parade of the sixth class at the R.A.A.F. College, Point Cook, near Melbourne, on December 10.

The College was founded in 1947 and its first class entered in January 1948. Both Australians and New Zealanders take the course, which lasts four years. Apart from the flying, which is up to wings standard (though without jet experience), particular emphasis is placed on the humanities. Technical cadets go to Sydney University (for aeronautical engineering degrees) or Adelaide University (for electrical engineering) at the end of their first year.

Already in its short history the College has acquired fighting traditions, for two of its former cadets gave their lives in Korea with No. 77 (Fighter) Sqn., R.A.A.F., and one won the D.F.C. there. This year Cadet E. A. Radford created a precedent by carrying off all the major prizes—the Sword of Honour, the Queen's Medal, the Flying Trophy and the Air Weapons Proficiency Shield. He is seen (above, left) receiving one of his prizes from the Duke of Edinburgh.

A general view of the ceremony is shown above (right) and in the informal group below it (reading from left to right) A.V-M. C. E. Kay, C.B.E., D.F.C., Chief of the Air Staff, R.N.Z.A.F., is seen with the trophy he presented to the College on behalf of the R.N.Z.A.F.; admiring it are the College Commandant, G/C. R. N. Dalkin, D.F.C., and the A.O.C. Point Cook, A. Cdre. W. Garing, C.B.E., D.F.C.

In the lower left picture the Duke takes a look at one of the College Winjeels after landing in an R.A.A.F. Dakota to take the parade; and, lower right, Cadet Radford shows his prizes to his instructor, F/L. P. Middleton, D.F.C.



HERE AND THERE

Sabre Shopping

AN order has been placed by the West German Federal Ministry of Defence with the Canadian Government for 225 Sabres for the West German Air Force, and the Canadian authorities have declared themselves willing to train German pilots to fly them.

Soviet Protest

IN a note to the State Department the Russian Government has protested to the United States about a "violation of Soviet air space" in the Vladivostock region by three U.S.A.F. B-57s on December 11. The note alleges their flight was made for reconnaissance purposes and "cannot but aggravate the international situation in the Far East."

Another Balloon Protest

A BROADCAST from Prague recently said that the U.S.A. had been photographing Czechoslovakia from the air by means of remotely controlled balloons carrying cameras.

Ballon D'Essai

THE French scientist M. Leprince-Ringuet has shown the Académie des Sciences photographs he has obtained with cameras lifted by balloons to a height of 20 miles.

Malayan Survey

IT was announced in Ottawa recently that Canada is to make an aerial survey of 35,000 sq miles of Malayan jungle as part of a search, under the Colombo Plan, for mineral deposits. The cost of this survey, which is expected to be complete by May, 1957, will be about £143,000 and the expenditure is to be divided equally between the two Governments concerned.

UPHILL WORK: One of a number of Italian Meteor F.L.55s sold to a Swiss operator for Alpine flying; it is seen after an uphill landing on skis, of the kind described in "Flight" of October 12. The location here is high in the Bernina Alps.

I.R.A. Precaution

FOUR Hastings of R.A.F. Transport Command last week flew 150 men of the R.A.F. Regiment to Northern Ireland, where they will be responsible for defending R.A.F. installations during the present border disturbances.

M.o.S. Appointment

WITH the agreement of the Secretary of State for Air the Minister of Supply has appointed A.V-M. C. D. C. Boyce to be Assistant Controller of Aircraft in succession to A.V-M. H. D. MacGregor.

Giving the Girls a Ride

DURING this year over 1,650 officers and cadets of the Women's Junior Air Corps have flown in the new W.J.A.C. aircraft, an Auster Aiglet called *Grey Dove II*, and in the course of these flights over 50 aerodromes in the United Kingdom were visited.

Ring in the New

ON January 1, 1957, the Texas division of the Bell Aircraft Corporation at Forth Worth officially becomes the Bell Helicopter Corporation. Mr. Harvey Gaylord, general manager of the division since 1951, has been elected president of the new subsidiary company.

N.S.W. Aero Club Presidency

AT the annual general meeting of the Royal Aero Club of New South Wales, held on December 8, Mr. G. A. Lloyd, Jnr., was elected president in succession to Maj-Gen. D. Macarthur Onslow, who has retired after holding the office for six years and is now a member of the committee.

ASCENDING STAR: bearing little resemblance to its stumpy predecessor is the Chance Vought Regulus II, a new surface-to-surface missile of the U.S. Navy. The revised machine is supersonic, and its turbojet needs a double-shock shark's-mouth intake. Test firings—probably not yet from submarines—are proceeding with success.

OVER 350
VICKERS VISCOUNTS

powered by
ROLLS-ROYCE
DART
PROPELLER TURBINES

have been ordered by world airlines

ROLLS-ROYCE AERO ENGINES LEAD THE WORLD

Concentration
on refining

AS MORE AND MORE PEOPLE wish to fly, and increasing numbers of aircraft are brought into operation to carry them, air transportation's thirst for oil grows.

To those who fly aircraft or who, as passengers, are carried comfortably and swiftly about the world, the familiar fuellers of BP Aviation Service are the outward sign of the very extensive organisation working behind the scenes to provide for these increasing demands. But long before these fuellers can perform their proper function, adequate refinery capacity must have been planned and built.

British Petroleum is making strenuous efforts to increase its refinery capacity, particularly to meet the fuel demands of the new Jet Age. Already new refineries are in production, and expansion goes on apace in Great Britain, Australia, Asia, Africa and in Europe. This concentration on refinery expansion will enable BP Aviation Service to play its part in meeting the air world's future jet fuel requirements.

AVIATION BP SERVICE

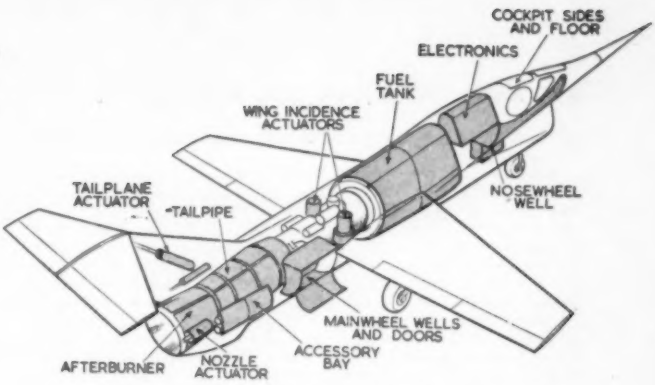
serves aviation well

The international aircraft fuelling organisation of
The British Petroleum Company Limited.

KEEPING HEAT IN ITS PLACE

Some Basic Problems of Insulation

By L. F. E. COOMBS



This diagram illustrates the probable disposition of some of the heat-insulating blankets in a hypothetical supersonic fighter. Components are not necessarily precisely to scale.

THE aircraft gas turbine, like all other heat engines, makes its presence felt bv radiating heat from its external surfaces. Unlike the reciprocating engine, which also radiates heat, the gas turbine (particularly in the form of a turbojet) gives off heat from 100 to 200 sq ft of surface; the "hot" parts of a piston engine are limited to the comparatively smaller area of the exhaust manifolds and pipes.

The heat emitted by the external surface of a jet engine is in the form of electro-magnetic energy, which can be passed from the radiating surface into and through any medium such as air or metal. Such energy is variously described, depending on its source temperature, as infra-red, visible light, ultra-violet, X-rays; each type occupies a band of frequencies in the energy spectrum.

At normal temperatures the heat of an engine is emitted as infra-red rays, which are invisible to the human eye. When temperature begins to approach the condition at which the surface begins to glow visibly, light rays are emitted.

The radiant energy emitted travels outwards until it reaches a medium or body which is usually at a lower temperature than its starting point. The receiving body or surface absorbs some of the energy and reflects the remainder. The proportion between the absorbed and reflected energy depends on the surface characteristics of the receiver; and this aspect of the problem introduces complications, as most surfaces which are subjected to bombardment by heat energy exhibit a variation in reflectivity with time. Very few metals are resistant to oxidation by heat; even stainless steels suffer surface oxidation after only a short period of exposure to high temperature.

Ability to absorb a proportion of the energy is measured in relation to the emissivity of the surface. The latter is itself related to the emissivity of a reference surface termed a "black body," which absorbs all the radiant energy to which it is exposed. Thus, the ability to absorb energy is compared with a "black body" under the same conditions. In addition to the change in characteristics caused by surface changes, such as corrosion, the surface emissivity is affected by its own "body" temperature, so there is not always a direct relationship between emissivity and absorption under the conditions obtaining in the vicinity of a jet engine.

The problem which has to be overcome by both airframe and engine designers is the prevention of damage to the aircraft structure from the radiated engine heat. Basically there are three courses that can be taken: (1) Intersperse a flow of air; (2) install some form of "material" insulation; (3) use a structural metal, such as stainless steel or Nimonic, which will maintain its strength at elevated temperatures.

The use of a flow of air around a jet engine is, up to a point, a simple method of insulation, but there are two major objections to such an easy way out. First, the air used for cooling is not available in large enough quantities during ground running, and during flight it represents a loss of power through added drag; the thrust produced by the difference in temperature between the upstream end and the exit of the moving column of air does not balance the drag loss. Secondly, as aircraft speeds increase the designer does not want to have to cope with additional entry design problems.

When an aircraft is intended for operations at flight speeds which will exceed Mach 0.8, or thereabouts, the designer has to contend with kinetic heat induced into the external surfaces of the airframe. Both engine and kinetic heat are similar in that they adversely effect the airframe structure, but they differ in intensity and quantity. Engine heat is represented by temperatures of (depending on location) 500 deg C to 1,000 deg C concentrated around the engine bay or pod, whereas kinetic heating affects large areas of the airframe skin, albeit at a somewhat lower range of temperatures.

Both kinetic and engine heat are dependent on time for the effects they can induce in adjacent structures and components. In a conventional transonic aircraft the effects of kinetic heat are retarded by time, so the structure can act as a large-capacity heat absorber. Of course, a problem does exist in that there is a temperature gradient from the external surfaces to the interior bulk of the airframe which could overstress the primary structural members, so some form of skin insulation is also needed. The type of insulation discussed here is, however, primarily intended for component insulation, and therefore it is assumed that the airframe under consideration has unlimited heat capacity and resistance to kinetic heat. The heat effects of a jet engine are more severe because the temperatures are higher and are maintained throughout the flight, so the structure adjacent to an engine will be subject to both engine and kinetic heating at the same time.

With a "hot" surface temperature of 600 deg C to 1,000 deg C the heat effects can only be delayed. Even although at time zero the "hot" temperature is say 600 deg C and the temperature of the structure one foot away is 60 deg C a time will eventually come, dependent upon the heat resistance and capacity of the structure, when the structural temperature will approach 600 deg C. The time to reach equilibrium may vary from a few minutes to a few hours; it is dependent on the material of the structure and the rate at which the heat is being carried away by a heat "sink"—a medium which has virtually unlimited capacity, such as air.

In practice the aircraft manufacturer is not always able to employ materials which combine reasonable cost, workability, acceptable weight and resistance to heat. Here we are primarily concerned with resistance to heat. The conventional materials of construction, the aluminium alloys, lose much of their strength when subjected to temperatures in excess of 150 deg C. As an example, after one hour at 200 deg C Duralumin might show a reduction in strength of 28 per cent. After 1,000 hours the strength might be down to only 30 per cent of the "cold" value. Though 1,000 hours is possibly an unrepresentative time, as flights will rarely exceed 12 hours, 1,000 hours might represent 200 changes in temperature—so it is reasonable to suppose that the strength would be even less than 30 per cent after 1,000 hours of operation.

In an endeavour to reduce the adverse effects on adjacent structure the designer can, as has been shown, provide a "boundary layer" of cooling air around the engine. Unfortunately there are limits to the amount of air that can be circulated in this way. The "tube" of air represents not only wasted space but also unwanted frontal area and drag. In addition, air taken on board for cooling is subject to kinetic heating; at present-day speeds the air temperature within the intake duct could be 100 deg C. Therefore, if alloys with a temperature limit of only 150 deg C are still to be used for structures then large quantities of air must be passed to give adequate protection. A small amount of air cooling is acceptable, and usually takes the form of an annular space between ½in and 1in wide. It should be noted that the protection offered by a moving airstream extends only to reducing the temperature of the "hot" surface of the engine. With a temperature of 200 deg C—the air is progressively heated as it passes downstream alongside the engine—there is not much reduction on the 600 deg C; and in any case the radiant heat, which is a function of the fourth power of the absolute temperature, is little affected by the air stream when the distance traversed is less than an inch. In the combustion chamber of a gas turbine air is used in a similar manner, and with success, to protect the chamber walls; but the axial distance traversed by the air, and the quantities involved do not compare with the conditions surrounding the engine itself.

The slight protection offered by an air shroud has to be supplemented by using an additional form of insulation. As in an electrical circuit, the more discontinuities and resistances introduced in series the lower the conductance. By balancing the drag-cost of an air shroud with the weight and cost of a material insulation, the designer endeavours to provide both a compromise and composite of protection for the structure and the components adjacent to a hot engine.

Having determined the amount of air that can be afforded for cooling, the designer has to adopt some form of material insulation

KEEPING HEAT IN ITS PLACE . . .

to retard the other 60 per cent of engine heat not carried away by the air shroud.

By adopting one of the totally enclosed thermal-insulation metal-clad blankets, such as those developed by Delaney Gallay, the designer can hand a proportion of his worries over to the insulation-blanket manufacturer. Blanket is, perhaps, a misnomer, as use is no longer made of flexible blankets on the principle of the laggings used on other vehicles, such as ships and locomotives. Present-day aircraft insulation blankets are usually rigid metal units shaped to fit the hot parts of an engine or a component.

The optimum in heat insulation cannot be achieved in a high-performance aircraft unless space and weight are considered to be of little consequence. In practice, both have to be taken into account and both compromise the optimum. Aircraft designers have restricted the depth of insulation to ½in and the weight to ½ lb/sq ft. Within these limits the insulation engineers have been able to drop the temperature across a ½in insulation from 600 deg C to 400 deg C. At temperatures lower than 600 deg C the temperature drop tends to become 50 per cent. A typical set of insulation comprising twenty units would provide a barrier to the heat radiated from 50 sq ft of jet-pipe for a weight penalty of only 30 lb. To give the same barrier by means of an air shroud might involve the drag penalty associated with a 2in-wide annular air shroud. In practice the advantage of using thermal insulation units is greater, as they can be installed within the diameter of the jet-pipe stiffeners.

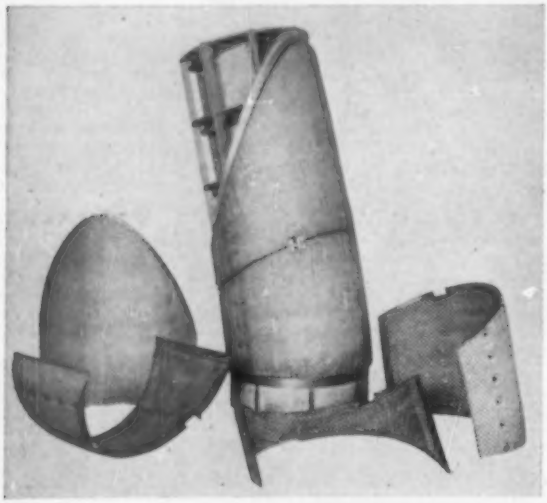
The design of insulation units has to take into account not only the heat-resistant properties of the refractory filling but also the environmental conditions of flight and ground running.

The structure of the unit—the metal casing—has to act as a container for the refractory material, as a protection against crushing of the refractory (such damage could nullify one of its heat-resistant properties) and as an anchorage for adjacent units and for its own support on the hot surface of an engine.

The container requirement is not difficult to meet provided steps are taken to prevent the ingress of inflammable fluids, which could occupy up to 90 per cent of the internal volume of an insulation unit. The prevention of crushing of the refractory is not easy and introduces one of the many compromises in the structural design of such types of insulation. The refractory material is similar in rigidity and strength to a loose felt with density of 3 to 4 lb/cu ft. Moderate pressure will crush the refractory fibres together, thereby reducing the number of air cells and increasing the conduction from fibre to fibre. The optimum insulation unit would have an infinite surface area, so that there would not be any conduction across the structure normal to the surfaces. The units are, therefore, made as large in area as possible. Apart from handling considerations, account has to be taken of the necessity to support the metal surfaces and to keep them the required distance apart. The maximum-area requirement, whilst reducing the specific weight, introduces large surfaces which are unsupported except at the edges. If distance-pieces are introduced then low-resistance "shunt" paths are provided from hot face to cold face. Large unsupported panels have always been anathema to engineers, particularly in relation to weight.

An insulation unit is subject to expansion and contraction of its own structure plus the dimensional changes of the engine surfaces to which it is attached. Also, in addition to having to accommodate changes in dimensions, its surfaces are subject to vibration. It is necessary, therefore, to stiffen the surface metal by grooving or dimpling. The material used for the "hot" and "cold" faces of a unit is usually 0.004in thick, and between grooving or dimpling rollers it exhibits some awkward characteristics. Stainless steel or titanium foils of those thicknesses cannot be stretched or compressed—only spread out or gathered into creases, folds, grooves or dimples. Of all the possible finishes, dimpling (after the manner of a chocolate-box stiffener) has proved to be the most adaptable to subsequent production operations. Whilst stiffening a sheet, the dimples still allow the forming of compound curvatures, whereas grooving (for example) places restrictions on forming.

These Delaney Gallay metal-clad insulating blankets are used in the installation of the Rolls-Royce Dart turboprop in the Fokker Friendship.



The unfortunate fact that the edges of an insulation unit are conductors of heat having been accepted, there is little to be gained by trying to provide a comparatively light high-resistance edge; instead, the edges are made as strong as possible consistant with normal aircraft weight restrictions. The usual method of joining the parts of the metal case is by resistance welding. The welding of material such as 0.004in stainless-steel foil is far removed from the techniques employed for heavier steels. It is necessary to have expensive control equipment to ensure that the welds are to acceptable standards; and as one of the cycles of the welding operation is the application of pressure, considerable ingenuity has to be exercised in the design of the insulation-unit structure in order to allow the application of welding pressure without crushing. This is just one of the production problems of an aircraft component whose dimensions are such that even midgets cannot be used to "back-up" the final weld.

Having dealt with the casing we may consider the refractory material or filling. The majority of fillings are composed of alumino-silica fibres which will maintain their structure in temperatures as high as 1,200 deg C. As the diameter of the fibres does not exceed ten microns the felted fibres are porous, so that when they are inserted into the metal casing of an insulation unit 90 per cent of the internal volume is air.

As an indication of the manner in which the refractory fibre felt accepts the heat-flow, it may be stated that 10 per cent is transmitted by conduction along the fibres, 60 per cent by radiation across the multitude of air cells formed by the enmeshed fibres and 30 per cent by air conduction. Such proportions would apply to a refractory fibre with a bulk density of about 3 lb/cu ft and at a mean temperature of 500 deg C. As can be seen, radiation and conduction are the principal transmitters of heat. The transmission rate can be varied by either increasing or decreasing the density of the refractory felt, or by varying its thickness. As the thickness is limited by space restrictions it is necessary to increase the density. Unfortunately, although increasing the density reduces the heat transferred by radiation it does not produce a corresponding worthwhile reduction in transfer by air conduction; and at the same time it entails an increase in weight. As in the case of the size of the insulation units themselves, the designer has to adopt a compromise in insulation-felt density. Present practice indicates that 3 lb/cu ft is the optimum figure.

This article is essentially concerned with the heat emitted by a gas turbine and in particular the jet engine. However, in present-day high-performance aircraft, and more so in the next generation of high-speed aircraft, the question of overall insulation will also have to be given very careful consideration. In addition to forming a barrier around the engine, metal-clad insulation units can be used for other purposes, as shown in the sketch on page 985. This indicates how the insulation units can be judiciously disposed so that the outward flow of heat from the engine or engines can be balanced with the inward flow of heat induced by flight at speeds in excess of Mach 1, so that no one part of the structure has to transmit an excessive heat load.

Although this article has dealt only with the insulation units as individual components it is not intended to suggest that the refractory fibre felt could not be used independently of the metal case. In certain airframe locations it might be possible to use unprotected insulation felt, though it would then be necessary to ensure that there was no reasonable possibility of the material becoming impregnated by an explosive liquid or gas. In addition, the presence of a layer of insulation against a primary structural member, such as a spar, might impede inspection.

Possibly the greatest danger to the structural stability of insulation units in jet aircraft is the presence of vibration, particularly when an afterburner is running. As an example, during early reheat tests British centrifugal engines high-frequency afterburner "screech" with a pressure variation of plus and minus 7 lb/sq in produced mechanical failure of engine components by forced vibration. Therefore, insulation units for use near high-performance engines must be capable not only of resisting forced vibrations, but—and what is of great importance—they must not be resonant to such effects. In present practice insulation units are usually considered as being expendable and, therefore, their design has to be a balance between first cost and life expectancy. Incidentally, it may be added that, in addition to acting as a barrier to heat energy, refractory insulation must also serve to a certain extent as a barrier to sound energy, particularly in the case of civil aircraft.

dual potential

FAIREY

in the forefront of aviation development

THE FAIREY AVIATION COMPANY LIMITED

ENGLAND AUSTRALIA CANADA

Right man in the right place

A front line man with a backroom background, the Shell Representative and Technical Adviser is ready to meet you at any airfield in his area to advise on all operational and technical problems associated with the use of petroleum products in aircraft. He is a part of Shell Aviation Service which serves the world's airlines throughout all six continents.

SHELL

SHELL WORLD-WIDE AVIATION SERVICE

987
FLIGHT,
28 *December*
1956

TEST OF FRIENDSHIP

Handling Fokker's Turboprop Airliner

By C. M. LAMBERT

OF all the Dakota replacements so far suggested, the Fokker F.27 Friendship is probably the one most like the dear old "gooneybird" itself. On a rather murky day earlier this month I flew the first prototype, PH-NIV, from Schiphol with Mr. H. V. B. Burgerhout, Fokker's chief test pilot, and Mr. A. P. Moll, who shares the Friendship testing. Also on board were a Fokker flight engineer, the publicity manager, Mr. H. A. Somberg, and a Japanese gentleman who, like representatives from many other nations, was interested in the Friendship. In fact, so great is the curiosity being shown by operators of every nationality that it was quite an achievement to be allowed to fly the aircraft, and I was not insensible of the honour.

My flight brought this first Friendship's time in the air to 319 hr, at a period when certification tests to C.A.R.4b requirements were in hand. PH-NIV was carrying a very large automatic observer installation in the forward freight cabin and steel-plate ballast which, with occupants and fuel, brought the weight up to the gross figure of 34,520 lb. The c.g. position was at 32 per cent, the permissible travel being from 20 per cent to 38 per cent. There was a cabin-heating system, supplied from the starboard engine, but neither pressurization nor soundproofing had yet been fitted. In spite of this, the noise-levels during flight were remarkably low. The engines are Rolls-Royce Dart Mk 511s.

The systems in the Friendship are pneumatic and electric. Flap and undercarriage are electrically selected and the undercarriage is pneumatically operated, while the nosewheel is pneumatically steered from a small handwheel on the left-hand cockpit wall. Pneumatic disc-brakes are worked from toe-pedals on the captain's rudder pedals. Undercarriage retraction time is very short; and all three legs are stressed to be used as speed-brakes, for 175 kt I.A.S. All flight controls are normal, connection between cockpit and surface being by cable and rods. Trimming is provided in all three axes and all surfaces carry geared tabs. A steel-spring bungee has been incorporated in the elevator circuit to apply a constant basic stick-rate, with the sole purpose of providing positive longitudinal stability in the extreme aft c.g. loading case at the higher speeds. This is in accordance with C.A.R.4b.

Kerosine fuel is stowed in integral tanks formed by the main wing torsion box outboard of each engine nacelle. A single gauge gives a quantity reading in pounds for each wing and flowmeters indicate the delivery to each engine. A cross-feed is provided. Water/methanol, carried in a glass-cloth plastic tank in the after part of each mainwheel well, is used for power boost. Being of plastic, the tanks easily resist the corrosive effects of water/methanol.

There are two separate electrical systems, each driven by one of the engines. In both cases there is a 28 volt D.C. generator supplying a 115 volt inverter and a 208 volt A.C., 400 c.p.s. alternator. These supply current for normal services and radio, for the electric flap-actuating motors and for tail de-icing, provided by Napier Spraymat units applied to the plastic leading edges. The wing is de-iced alternatively by a Goodrich inflatable-boot system applied to a plastic leading edge, or by hot air led through passages formed by corrugated underskin applied to a metal leading edge.

For ease of access and maintenance, all electrical circuit-breakers are grouped on the after wall of the flight deck; and all electrical and radio equipment is stowed on handy racks aft of the co-pilot's position. In similar fashion, all pneumatic valves and components are grouped on the after face of the flight deck wall behind the captain. The controls of the electrical services, bus-bar selectors and volt and amp meters are distributed in the roof panels of the cockpit. Here also are the basic autopilot controls, the two A.D.F. panels, the two V.H.F. selector boxes, I.L.S., engine-starting controls and a number of the emergency controls.

Pressurization is controlled on the co-pilot's right-hand side. Flap switch and undercarriage push-buttons are on the right-hand side of the main control pedestal, their respective indicators being beside the engine instruments. Engine and propeller emergency controls and warning lights are on a small panel immediately above the main block of engine instruments. On each side of these there is a block of seven blind-flying instruments (including I.L.S. meter), surrounded by a yellow outline to make them readily discernible. Near them are two dual A.D.F. indicators, two clocks and such additional items as marker-beacon indicator lights and "coffee-grinder" handles for rudder-pedal adjustment. Cockpit background colour is pale grey and all dials are black.

The forward step of the main control pedestal has two elevator trim wheels, each with its own trim-position indicator, two pairs of engine power levers and two high-pressure cock/feathering levers. Rudder and elevator trim wheels, flanked by their indicators, are mounted in their natural sense at the after end of the pedestal. Each pilot's seat can be adjusted for height and, by sliding, for leg reach. Rudder pedals, too, are adjustable. The pressurization level, at a little over 4 lb/sq in, is low and the windscreen has been made of generous size. It affords excellent visibility, so that roof windows are hardly necessary.

Accessibility for maintenance has been particularly carefully studied in the Friendship. Apart from the grouping of electrical and pneumatic components, all control cables pass outside the pressure cabin at a point over the forward part of the freight cabin. From the wing leading-edge forward the fuselage cross-section is oval while that of the pressure cabin itself is circular. The cables pass through the free space left between pressure hull and outside skin. Aft of the wing they run inside the large dorsal spine on which the dorsal fin itself is mounted. Big hinged panels can be opened in this area to expose control cables and much of the air ducting.

Glass-cloth plastics are used to a remarkable extent in the Friendship. The whole nose-cone, nosewheel fairing doors and hinge brackets, ice-protection plates opposite the propellers, the leading-edge inboard of the nacelles, non-moving portions of the wing aft of the torsion box, the whole wing-root fairing, tailplane and fin leading edges, elevator nose section and nacelle tail-cones,

TEST OF FRIENDSHIP . . .

(Left and right) The Rolls-Royce Dart Mk 511 and the electrically de-iced Rotol 12ft propellers. The nacelle cross-section is oval, with the generators and other accessories grouped well aft at the wing leading edge and covered by a single hinged panel (just visible on the right).

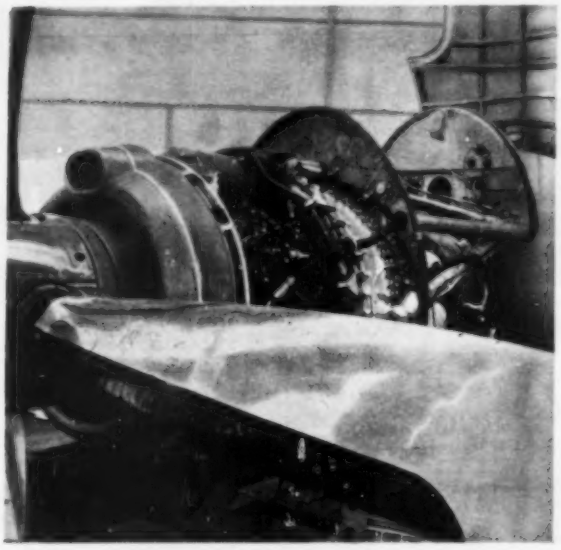
not to mention water/methanol tanks, cabin luggage racks and a good deal of air ducting—all these are of plastic. Such lightly-stressed parts can be made simply and lightly in glass plastic, allowing a much-improved skin contour and greatly increased ease of manufacture, particularly where complex compound curvatures exist.

In the control of the Darts a single power lever is used for both engine power and propeller pitch. In all routine work away from the circuit the indication of power delivery is taken from the r.p.m. gauge. Because of operating requirements the engine is set to run at a minimum speed of about 10,000 r.p.m. in flight. If engine power is reduced below that normally used at this speed, propeller pitch will automatically fine-off in an attempt to maintain the minimum r.p.m. In this process there comes a time when the propeller will fine-off completely and give tremendous discing drag, which would prove fatal if it occurred in the air. A mechanical fine-pitch stop is therefore set at 21 deg. Once the propeller can no longer hold the 10,000 r.p.m. at 21 deg pitch it acts virtually as a fixed-pitch unit giving a certain amount of wind-milling drag. For starting purposes, however, and for various conditions on the ground, the propeller must be allowed to fine-off completely to zero deg. Micro-switches are therefore fitted on the main undercarriage units to withdraw the flight idling stop and allow pitch to go to zero deg when the weight of the aircraft rests firmly on the mainwheels.

The engines are started at zero deg and, when power is applied on the ground, engine speed very soon increases to the 10,000 r.p.m. mark. Taxying is usually done at this r.p.m. During an approach and landing, when the propellers are against the flight-idling stop, r.p.m. is obviously no longer an indication of power delivery and reference is made to the torquemeters, which are mounted immediately below the r.p.m. gauges. As soon as the aircraft touches down the propellers can come back to the zero-degree ground fine-pitch position and there is a noticeable increase in r.p.m. a few seconds after touch-down. A good deal of discing drag is then available to reduce the landing run. The torquemeters, of course, continue to give an indication of power delivery in all flight conditions but, under cruising conditions, they are mostly disregarded.

When I flew with Mr. Burgerhout and Mr. Moll I was unfortunately not able to make any take-offs or landings because, with the low cloud-base and poor visibility then obtaining, two Friendship-qualified pilots were necessary to cope with the traffic control and radio procedures in force at Schiphol. I therefore stood behind the flight engineer as he sat in the jump seat, which unfolds from the floor in the flight-deck doorway.

We had no sooner taken our places than the starboard engine began its characteristic starting-up whine. Immediately afterwards the port engine was started. Very short checks, mainly listing items in the electrical system, were carried out. The ground generator trolley was waved away and we began to taxi. Mr. Burgerhout used nosewheel steering and braking, with the engines at a little over 10,000 r.p.m. The ride was comfortable and



visibility from the cockpit excellent; we consequently had no trouble in negotiating some gateways and taxi-way marker boards which were scattered in some profusion over the first part of our route to the runway.

The take-off run, at full load, lasted about 15 sec and was followed by very quick wheel retraction and a good steep climb straight into cloud. At this point I sat in a seat next to the automatic recorder installation, and right in the line of the engines. I had two main impressions; firstly, that the quality of the noise was remarkably similar to that in a Viscount passenger cabin during take-off; and secondly (and as stated earlier), that despite this first prototype's lack of proper soundproofing, furnishing and pressurization, the noise-level was not at all excessive.

We were soon clear of broken cloud tops and climbing in bright sunshine when Mr. Burgerhout handed over control to me. Initially I had a little difficulty in bringing the seat forward again after getting into it, since the catch simply unlocks the seat on its rails; and, during the climb, it kept sliding firmly to the fully back position each time I unlocked it to slide forwards. I could have saved myself a lot of jerking and leaping if I had simply used the obvious hand-hold on the anti-glare shield to pull myself further forward. We were climbing at 120 kt and making good about 1,400ft/min rate of climb at 13,600 r.p.m.

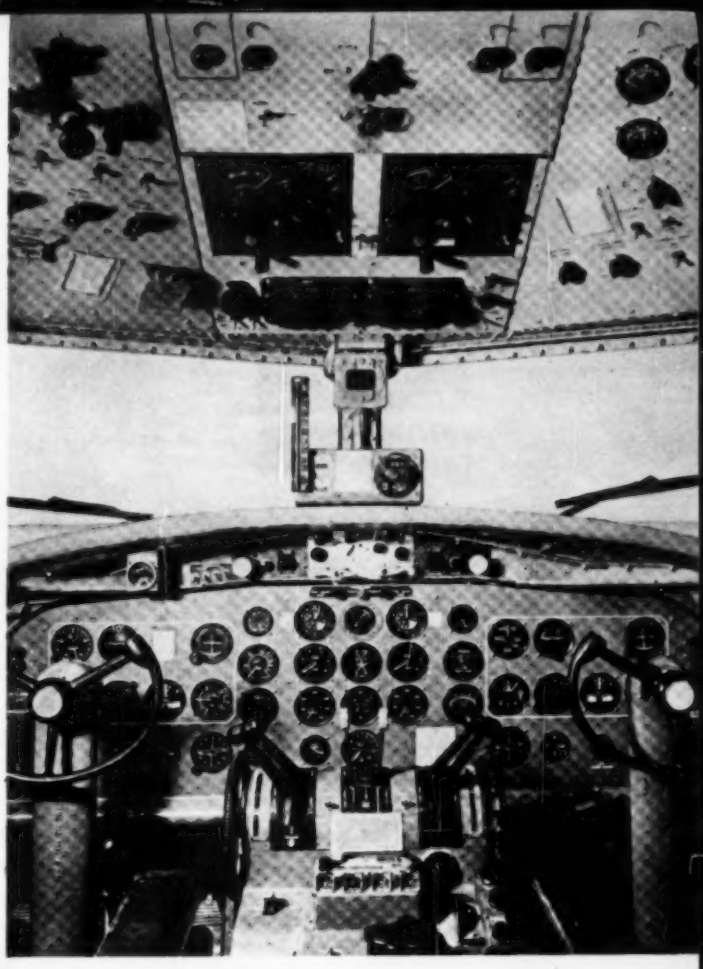
I climbed to about 6,000ft and levelled off, leaving a high power setting to take us comfortably to 205 kt I.A.S. Both A.S.I.s were of the sensitive type with hundreds of knots shown in a veeder window and units and tens indicated by a single needle. These instruments are fitted for test purposes. Engine r.p.m. response to power-lever movement was slightly delayed, resulting in a tendency on my part to over-control initially. To synchronize engine speeds I had to adjust one of the power levers very slightly until the needle of the synchronization indicator ceased to revolve. If the needle was spinning clockwise, starboard engine power had to be increased; if anti-clockwise, the opposite. No "beat" was heard until one engine ran several hundred r.p.m. faster than the other.

The simple pneumatically retracted undercarriage folds backwards into the wheel bay. It has twin Dunlop wheels, pneumatic disc brakes with Maxaret, and Dowty shock-absorbers. Dowty and Dunlop also feature in the nosewheel assembly, which is pneumatically steered. A great deal of the Friendship's equipment is British-made.

The amount of fuel supplied to the engines is regulated according to altitude by a barometric control which is set for I.C.A.N. temperature conditions. Such a setting would not, however, give the optimum fuel consumption in all conditions; and two further indicators show in which way fuel trimmer switches should be moved to achieve the optimum fuel consumption. For take-off and landing the fuel trimmers were set for maximum supply.

Flying round for a time at 205 kt to get the feel of the Friendship, I was immediately impressed with its preciseness of control. One does not expect really spritely manœuvrability from an aircraft of this size, but neither does one often get such easy and smooth response to control movements. The rudder, particularly, was light and effective at that speed. The aircraft flew "hands-off" perfectly happily and the ailerons gave a good rate of roll. The elevator needed a fairly pronounced increase in force with increasing stick movement; and in sustained applications, such as during steepish turns, it was quite heavy—as, indeed, it should be in a transport aircraft. In such conditions it would be more comfortable to make use of the elevator trim, as the nose has to be held up in a turn. Only very slight application of rudder was needed to initiate a turn.

I let go of the wheel and applied left and right rudder, noting that the response in roll was greater than the response in yaw. With the aircraft trimmed straight and level at 205 kt, I pulled the nose up about 10 degrees and let go. The speed dropped back to 195 kt and the nose went very slowly down. Speed then increased to a maximum of 214 kt, the nose came up, and the aircraft settled straight back into a hands-off cruise at 205 kt. My



Controls and instruments are well distributed over the central pedestal, main panel and roof panels. **Background is grey with dials and levers black. Flight instruments are outlined in yellow. Power levers and elevator trim wheels are duplicated. Light switches, autopilot controls, electrical meters and buss-bar selectors, fuel and engine-starting controls, duplicated A.D.F., V.H.F. and V.O.R. and I.L.S. controls are in the ceiling. Engine instruments in the centre of the main panel include r.p.m., torque, fuel and oil pressure gauges, oil and jet pipe temperature gauges, two-needle fuel flow-meter, fuel trimmer gauges, fuel quantity indicators, engine synchronization instrument and flap, undercarriage and brake pressure indicators. Engine and propeller warning lights and emergency controls are under the coaming. The two centre levers on the quadrant are high pressure cock/feathering controls.**

The Friendship seen under the wing of the Fokker F.VII.

general impression was that the Friendship would be extremely comfortable for long periods of cruising.

Mr. Moll, who was still in the co-pilot's seat, was recovering from a severe cold and could not speak very loudly; but by leaning halfway across the space between us and cupping his hand over his mouth he was able to talk naturally to me and be clearly heard. I noticed also that there was no sound of air hissing round the windscreen. At this speed the noise level was evidently very low

Mr. Moll suggested cutting one engine; and on a signal from me he pulled the starboard high-pressure cock to the off position to cut off the fuel supply to that engine. The Friendship veered momentarily to the right and became slightly right-wing heavy, but otherwise carried on as if nothing had happened. Mr. Moll then pulled the high-pressure cock back through a gate to the feathering position, whereupon propeller pitch became so coarse that the drag was negligible although the propeller was still turning. At a convenient time after that a button can be pressed to actuate a solenoid and put the propeller into the true feathering position, where it stops rotating. When the feathering button is pressed a bulb mounted inside it lights up and after a few seconds goes off again. I could not see the starboard propeller from the left-hand seat.

With one engine cut the speed came very slowly back to 184 kt, at which point I tried a turn into the live engine. This seemed perfectly normal, though the speed fell off a little more quickly. At 180 kt I had all forces trimmed out with half rudder-trim and the speed was still settling very slowly. I was told that with one engine at cruising power speed settles down to slightly above 160 kt and that turns in either direction at 60 deg bank are quite comfortable. The rudder trim is effective and well geared and a "coffee-grinder" handle can be unfolded from the large knurled trim-knob to allow rapid winding-on of trim. The aileron trimmer also has this rapid-winding facility. The elevator trim wheels are large and close to hand and highly geared, so that only very small movements are required. Trimming in this sense is most effective and at no time during the flight did I use more than one-third of the available range, distributed equally about the neutral mark. The very wide elevator trim range available is specifically designed to allow for large variations in c.g.

I then took the Friendship back to 90 kt with about 20 deg of

TEST OF FRIENDSHIP . . .

Little Dutch girl peeping; to her left the plastic fuselage ice-protection plate and freight door.

flap. Application caused a fairly strong nose-up trim change, which could be immediately trimmed out. Maximum speed for 20 deg flap is 140 kt.

With the starboard propeller feathered and the port engine throttled back at 90 kt I.A.S., and 20 deg of flap, Mr. Moll applied maximum continuous power on the "good" engine. To keep straight I had to exert a considerable force on the rudder and use a certain amount of aileron as well. With both aileron and rudder trim set fully against the "good" engine, I still had to apply rudder force, but the aircraft was quite controllable. Power was then increased to the take-off setting and the control force became slightly greater; but, at about 5,000ft, we managed to obtain something approaching 500ft/min rate of climb. In these conditions I could feel buffeting on the rudder. The V_2 speed—i.e., that at which, during take-off at full load, the pilot would continue the take-off if one engine failed—is 95 kt.

We now turned our attention to stalling. Mr. Moll made the few movements necessary to relight the starboard engine and I retrimmed at 5,000ft at about 120 kt. First, with the aircraft clean and both engines idling, I let the speed fall off steadily. At a little over 90 kt I could feel slight buffeting and was using a fair amount of force to hold the stick back. We were sinking at about 1,000ft/min, not quite stalled. A final tug back on the stick produced a decided buffet and the nose fell away with no sign of wing-drop. Immediately the nose was well down the speed built up and, with or without application of power, a recovery from the gentle dive could be initiated without signs of a new stall. It is a particular characteristic of the Friendship's stall that it recovers virtually of its own accord and gains speed very quickly once the nose goes down. There is no appreciable interval between the full stall and regaining flying speed, and the stick needs only to be centralized or pushed slightly forward. We regained height, applied 20 deg of flap and, with the engines idling, once more let the speed fall off.

In any of the "dirty" configurations I found I had to use rudder to hold the Friendship straight, and aileron to hold the right wing up, some time before the stall was reached. Knowing little about the aircraft I was unwilling to approach a stall with the controls not virtually centralized, yet I could not keep straight and level without using aileron and rudder. Deciding therefore on a compromise, I reached the buffeting point and then the full stall, at just under 80 kt, with the right wing a little low, some yaw to starboard and very slight control application. The result was that, when the nose fell below the horizon at the point of stalling, the right wing went slowly down as well. It was in no sense a wing-drop such as one might experience, for example, in a Harvard. The nose dropped more sharply than before, but once again the recovery was immediate and required the minimum application of controls.

The final stall was with full flap, undercarriage down and engines idling. This time I used almost half port aileron and a fair amount of rudder as the speed came slowly back towards 70 kt. I should, however, have used even more control to hold things straight; when the stall came, at a fraction over 65 kt, the nose and the right wing went down more sharply than before. But the Friendship again recovered immediately, though this time we were in a fairly steep spiral dive to the right. The pre-stall buffet was clearly felt in the cockpit, but it was apparently much more pronounced in the aft fuselage; I hope I did not unduly disturb the Japanese gentleman, whose patience and forbearance I can most highly commend.

One noticed that, to maintain a constant rate of decrease of speed of about one or two knots per second, the Friendship's nose had to be pulled progressively up above the horizon as the stall approached. Thus, if a constant attitude was maintained, the rate of decrease of speed became less and less as the stall approached.

After this I put the Friendship into a power-off glide with everything out and down. At a speed of about 95 kt I applied full power in a simulated overshoot. The result was very satisfactory, without any pronounced trim changes and with a smooth positive acceleration and climb. Retraction of the undercarriage (and extension also) produced no trim change at this sort of speed. Retraction of flaps gave a slight nose-down trim change and considerable acceleration.

During these manœuvres we had been flying above cloud somewhere in the area of the Dutch coast, and Schiphol control now gave us the alternative of landing immediately or holding above cloud for another hour. We therefore elected to come down right away and I changed places with Mr. Burgerhout so that he and Mr. Moll could do the instrument let-down. It is standard practice with the Friendship to make the descent from cruising height, using the undercarriage as an airbrake, at about 160 kt I.A.S. The resulting rate of descent is about 2,000ft/min. With the aircraft clean, a descent from 20,000ft would otherwise take longer than the initial climb to that height. When the undercarriage goes down at 175 kt it produces pronounced deceleration.

Sitting in the engineer's jump seat, I watched the two Fokker test pilots position themselves with the aid of the A.D.F. and join the I.L.S. approach beam. We went into cloud at 2,000 or 3,000ft and came out beneath it, on the glide-path, at about 800ft. In the approach condition the Friendship is obviously perfectly easy to fly, and for long periods Mr. Burgerout left the controls entirely alone as the aircraft went smoothly down the glide-path with the I.L.S. needles centred.

Final approach was at 95 kt and a gentle round-out led to a touch-down at 80 kt with the nose fairly high. Seconds after touch-down the propellers went into zero pitch and speeded up. Hardly any braking was required before we turned off about halfway down the runway. From the jump seat the operation looked simplicity itself. Some way out from the Fokker hangar Mr. Burgerhout cut the port engine and taxied on the starboard alone, using brakes and nosewheel steering. Mr. Moll meanwhile completed a few cockpit checks and, in answer to my question, said that the Friendship taxied quite as well on one engine as on two. The object of switching off the port engine was to allow the propeller to stop turning by the time we reached the apron. We could then open the freight compartment door and climb straight out without waiting. Propeller brakes are not fitted and not necessary, since the propeller is directly connected to the engine's main rotating assembly. The drag of this is quite sufficient to stop the engine on the ground.

I liked the Friendship because it combines the performance and size of a transport aircraft with the pleasant and straightforward handling characteristics and simplicity of operation of a much lighter executive aircraft. I have the impression that it is the sort of aeroplane which an executive or an airline pilot would be pleased to fly over long or short distances, operating from large airports or small airfields. It is not too much of a handful for one pilot; two would find it very comfortable and simple.

FOKKER F.27 FRIENDSHIP: PRINCIPAL DATA

Two Rolls-Royce Dart RDa.6 Mk 511: 1,600 h.p. plus 370 lb thrust each at take-off.

Span, 95ft; length, 76ft; height, 27.5ft; wing area, 754 sq ft; aspect ratio, 12; fuselage diameter, 8ft 10in; length of pressure cabin, 53ft; cabin height, 6ft 8in; minimum cabin height, under wing, 5ft 11in; undercarriage track, 23ft 7in.

Design gross weight, 34,520 lb; max. landing weight, 33,000 lb; max. zero fuel weight, 31,210 lb; wing loading, 45.8 lb/sq ft.

Max. speed at 20,000ft with 13,800 r.p.m., 280 m.p.h.; economical cruising speed at 20,000ft with 13,600 r.p.m., 275 m.p.h.; service ceiling, 34,000ft; single-engined service ceiling, 15,700ft; take-off field length for C.A.R.4b, 3,400ft; maximum stage distance at maximum take-off weight, 980 miles.

Two important jet trainers are depicted in these new views. Left, the first Hawker Hunter T.7 shows off its fine lines. The other aircraft is a Lockheed-Canadair Silver Star T-33 Mk 3 (to give its full designation) in R.C.A.F./NATO finish.

AIRCRAFT INTELLIGENCE

Great Britain

Scottish Aviation Twin Pioneer. Already having evaluated the Pioneer, the U.S. Army is reported to be showing an interest in its twin-engined successor. Noel Capper, chief test pilot, is expected to fly a Twin Pioneer out to Fort Bragg at the end of the year—by way of Keflavik, Sondrestrom and Gander—and to follow with a tour covering Canada and South America as well.

U.S.A.

Boeing B-52. Most B-52s in service with Strategic Air Command carry a minimum flight crew of six, with a maximum of twice this number on very long, flight-refuelled missions such as the 17,000-mile non-stop flights by aircraft of the 42nd and 93rd Heavy Bomb Wings. Both pilot and co-pilot sit in ejection seats which fire out through roof hatches, while the two observers eject downward. The tail gunner can jettison the entire tail cone, complete with multiple radars (including General Electric monopulse radar gunlaying) and barbette of four 20mm guns.

France

Leduc 022. From Istres comes the news that the first of the two Leduc 022 supersonic ramjet experimental aircraft is at last complete, and flight trials are to begin early in the new year. Powered by a S.N.E.C.M.A. Atar turbojet mounted within a ramjet built integral with the fuselage, the 022 is the first high-supersonic machine in the Leduc series; it is designed for Mach numbers greater than two. The second aircraft will be completed to incorporate lessons learned from the first. Leduc pilots Littolff and Sarrail will handle the flying.

Morane 760 *Paris*. A contract is currently being agreed under the terms of which the Argentine government will purchase 48 of these twin-jet training and liaison aircraft, with the option of increasing the quantity to 100 by the end of June next. Argentina will be authorized to assemble the Paris at Cordoba and to supply the type to neighbouring countries.

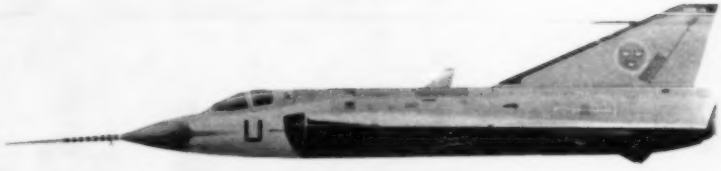
Nord 2501 *Noratlas*. A large number of these twin-boom transports, powered by S.N.E.C.M.A.-built Bristol Hercules, operated with conspicuous ability during the Suez campaign. The first of 137 for the West German air force was delivered last month and other machines are touring Finland and Brazil. An unusual aspect of Noratlas versatility is that the aircraft can carry virtually all its spares, including mainplanes or tail booms; and, if necessary, a pilot compartment and front end can be attached in place of the usual double clam-shell doors.

Italy

Aerfer Sagittario II. The prototype is being flown by Lt-Col. Franchini of the Italian government's flight-test centre. The aircraft exceeded sonic speed at the beginning of December and tests are continuing in some secrecy from the airfield of Pratica di Mare, near Rome.

Partenavia P.55 Tornado. This very fast, 140 h.p. two-seater is reported to be preparing to attack various speed records in the 500 to 1,000 kg (1,100 to 2,200 lb) class.

SAAB 35 DRAKEN
(S.F.A.-built Rolls-Royce Avon)
Span ... ... about 33ft
Length ... ... about 45ft

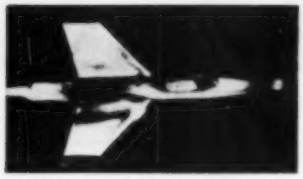


THE N.A.C.A. LANGLEY A

SITUATED at Langley Field, Virginia, the Langley Laboratory is one of the principal research facilities of the National Advisory Committee for Aeronautics. The accompanying photographs give some idea of the scale of equipment provided by this valuable centre.

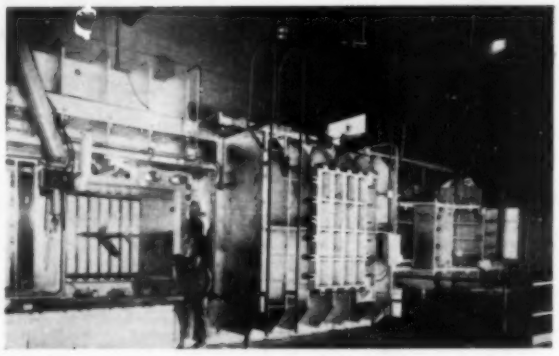
The strip of small photographs across the top of these two pages depicts the progressive breakdown and disintegration of a small stainless-steel model placed in the 7,000ft/sec jet from an acid/ammonia rocket. The respective times from the start of the run are indicated beneath each photograph.

0 sec.



0·9 secs.

Fig. 1. Approximately £5.5m has been spent on the Unitary Plan supersonic tunnel, in which multiple circuits cover Mach numbers from 1.5 to 5.0. In this photograph, a model of the Bell X-2 research aircraft is installed for calibration in a test section 4ft square with a rear door made from nine panes of optically finished plate glass separated by vertical steel webs.

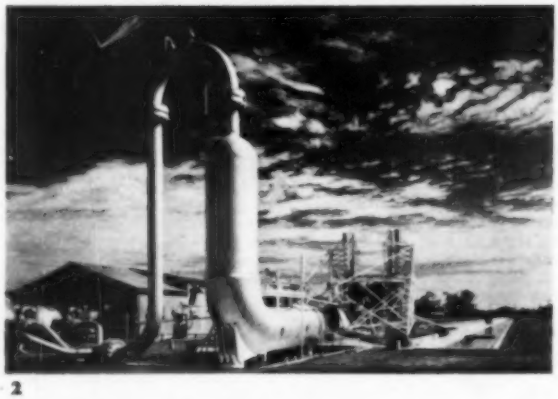


1

Fig. 2. The apparatus in the foreground is a 3,260 lb/sq in air system which expels water from the L-shaped tank through a nozzle; the resulting 660ft/sec jet impinges on a bucket, creating a static thrust of 400,000 lb. The bucket is, in turn, attached to a free carriage used for drop testing of undercarriages and other components.

Fig. 3. This model, which may well be of the Martin XB-68 supersonic bomber, is undergoing stability evaluation under low-speed conditions in the 300 m.p.h. 7ft by 10ft tunnel.

Fig. 4. This impressive photograph shows the junction of air passages leading to two test sections of the Unitary Plan tunnel. Both sections are 4ft square, and respectively cover the ranges M = 1.5 to 2.7 and M = 2.5 to 5.0.

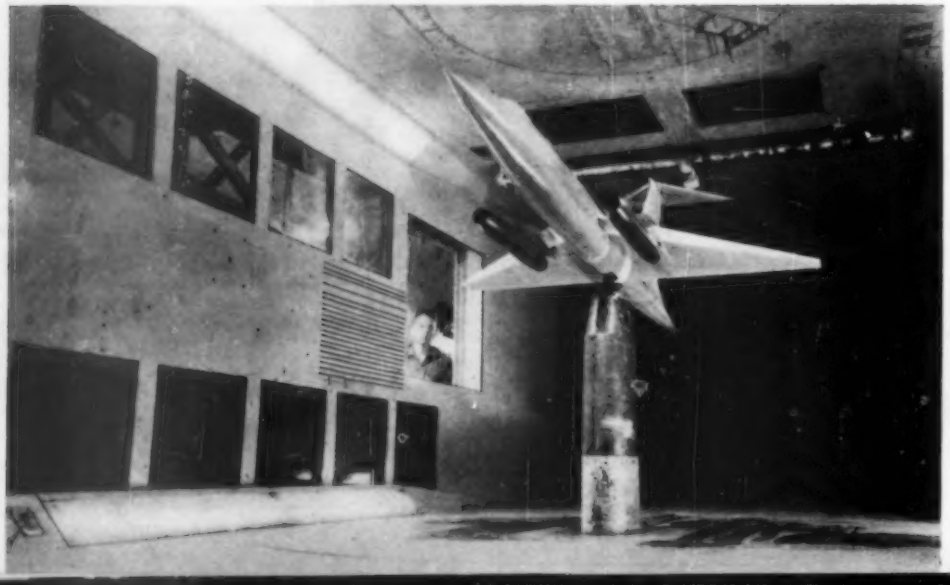


2

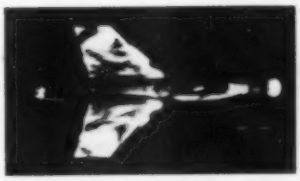
Fig. 5. Another test in the 7ft by 10ft subsonic tunnel concerns the spinning characteristics of the Chance Vought F8U Crusader supersonic fighter. In this picture, the variable-incidence wing is in the "high speed" incidence position.

Fig. 6. Transonic static stability of the North American F-100 was investigated with the 8ft square transonic pressure tunnel. A point of particular interest is the slotted throat of the test section, clearly visible in the roof panels.

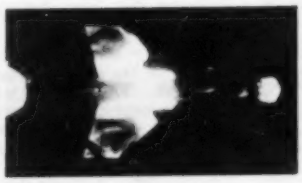
3



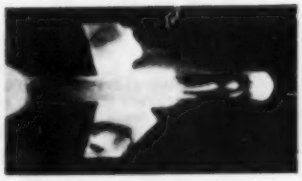
AERONAUTICAL LABORATORY



2·5 secs.

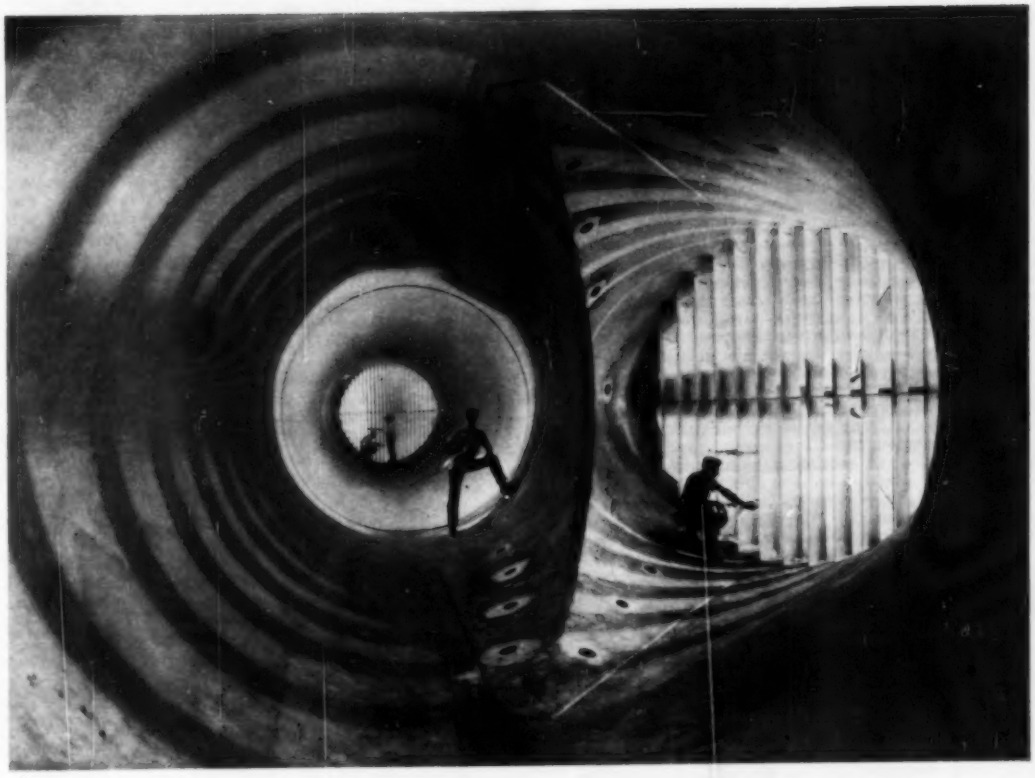


4 secs.



5·3 secs.

6·7 secs.



4

5

6

Research, Development and Technical Issues

The 1956 Wright Brothers Lecture by Sir Arnold Hall

AS recorded last week, the Wright Brothers Lecture for 1956 was delivered before the Institute of the Aeronautical Sciences in Washington on December 17. The lecturer was Sir Arnold Hall, F.R.S., technical director, Hawker Siddeley Group, and his paper was entitled "Some Comments on Current Aviation Topics." It is now printed almost in full, beginning in these pages: we hope to publish Part II next week.

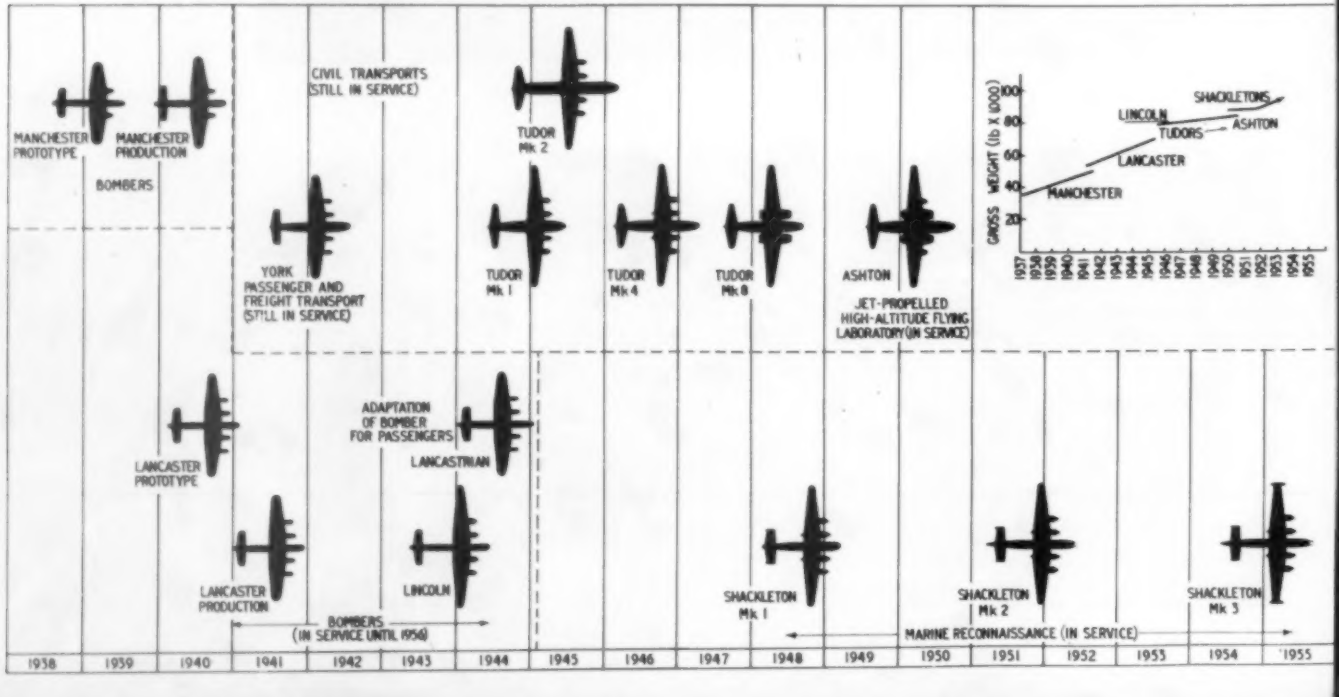
THE lecture [said Sir Arnold in his introduction] falls into two parts; the first contains comments on administrative matters affecting research and development, and the second contains comments on some current technical issues particularly affecting civil aviation. Since aviation is a matter of great public interest, and since it disburses considerable public funds, it is not surprising that it should be the subject of inquiry from time to time, and I have on many occasions been called to answer questions in such circumstances. I have found that processes which are well known to engineers are often by no means fully understood by the people who become involved in these matters, and Part I of this lecture embodies statements and opinions on points I have found to be obscure to intelligent but non-professional inquirers. Part II is an attempt to set down some of the technical factors which will control aviation development in the coming years; it is by no means a complete statement for the reasons I have mentioned above. The opinions expressed are my own and do not necessarily reflect the views of the official establishment with which I was, until recently, associated, or the group of companies with which I am now associated.

The Research and Development Process. Technological progress comes about in both an "unorganized" and an "organized" manner. The organized approach is largely a 20th-century invention and aviation has had a lot to do with introducing it. The steam engine was not invented because a government department set out to have it invented—neither was the first aeroplane; but most of the rest were the products of an organized approach to an extent which has increased as time has gone on. In organized research and development, progress is sought as a matter of policy, either by the State or by large private undertakings, and they bring together the people and the equipment thought necessary to achieve it to an extent far exceeding the financial capacity of any individual worker. This has brought about the large-scale employment in many countries of scientific and technical people, loosely described as "scientists." These large numbers of "scientists," except on rare occasions, do not contribute to the advancement of science in the classical meaning of the term; they add little to the broad sweep of our understanding of the universe in which we live. They are essentially concerned with detail well within the outer boundaries of scientific knowledge, but detailed mastery of the fine structure is vital to efficient engineering exploitation. The broad science on which aerodynamics is based was to a large extent complete before the Wrights flew the first aeroplane; such men as Newton, Reynolds and Mach had seen to that. But the application of the established principles of understanding presents problems of the greatest detailed difficulty, and it is with these problems that the mass of modern scientific workers are concerned.

Advance in technology comes in several ways, but some specific trends are recognizable. There are radical departures from the situation that exists; typical of these are the change from wood to metal in construction, the move from the 350 m.p.h. regime of aviation during the Second World War to the 600 m.p.h. regime of the present high-subsonic military and civil aircraft, and the jump now taking place from the subsonic to the supersonic regime. These jumps produce a new position which is then usually the subject of "development." This produces very effective, if not radical, advances, involving the exploitation by detailed change of a device already achieved. This process is often taken further by "continuity of development," which carries on the process of simple development by the creation of a new device essentially similar to that from which it was derived, and based on the same knowledge, but freed from the limitations—perhaps of size or strength—which brought the exploitation of the original to an end.

There are four phases in the attainment of a radical departure, which then forms the basis for further development. The first is that of "undirected" research in which detailed knowledge over a wide front is accumulated. The next phase starts when it becomes evident that a basis of knowledge sufficient for building a useful engineering device is in sight, and at this stage the research becomes more pointed in the direction of the project visualized. The third stage starts when a decision is taken to attempt the project; then the normal mechanism of engineering design comes into play, research becomes more pointed still in those directions where the knowledge upon which the project must be founded appears to be weak, and detailed technical work specific to the particular geometry of the project starts. There is then the fourth stage of making the project work in every detail. Usually there are a variety of "snags" to overcome, some of which may well involve further detailed scientific work. Meanwhile, arrangements for production have been in hand; this process also involves very considerable research, since the manufacture of new and advanced devices always poses new problems in workshops. So what might be described as the Mk I of a series is produced.

Fig. 1. A typical example of aircraft development, showing what evolved from the original Avro Manchester, designed in outline in 1936.



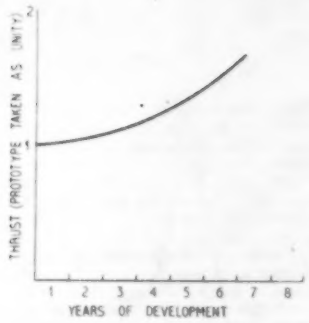


Fig. 2. Increase of thrust from typical jet engine, due to development.

In this process the choice of time for the initiation of the engineering phase is crucial. If the project is highly commercial, so that the main consideration is that it will sell successfully and perform in a way giving every satisfaction to the customer, the engineering work must not be started until the basis for detailed knowledge, upon which its success depends, is very complete—so complete, in fact, that there are no doubts of an even mildly serious nature. Not many aeronautical projects have been of this type, though there have been some. If, however, there are military matters involved, then the main issue is that there shall be a counter to any threat the potential enemy may mount, at or before the date on which he mounts it. If the political situation is such that this matters a great deal, the element of risk accepted in the way of incompleteness of detailed knowledge upon which to base the project must be greater—technical advantage will go to those who balance risk and time most successfully. If complete success in the sense that it meets everything everybody had hoped for is demanded from the Mk I of a new military project, it will almost certainly be too late to counter the threat it was intended to meet because, to ensure success, it will be started at a later stage in the build-up of background knowledge. In highly competitive aviation development of the kind we have seen in recent years, technical risks must be run; the alternative is to accept that the potential enemy, taking a greater technical risk, may get through and secure a dominant lead.

What is learned during the project stage is not so much new basic knowledge, but how to exploit the original basis of knowledge in terms of what is often called "hardware," and much of this learning is specific to the particular geometry involved. During the time taken in bringing the project to fruition, the basis of knowledge upon which it is founded rarely changes much.

Generally, by no means all that there is to learn can be applied in the Mk I stage, and Mk I projects usually do rather less well than their designers had hoped. They form, however, the essential foundation for development; it is usually the Mk II design—an amended version of the first—which brings the exploitation of the scientific foundation within full view. There are at least two reasons for this. First, no designer is so gifted as to be able to see on the drawing board every possibility of detailed improvement in his project; things are very different when a Mk I has been made and experience gained in its use. Second, what is thought to be most important often changes with time, and a different and more advantageous balance of the give and take between the various performance characteristics becomes acceptable when it is seen against the background of the achieved performance of the Mk I machine.

The long course of development and the gains it brings about, though well known to engineers, are less appreciated by those without direct experience of it. Fig. 1 illustrates a typical example of the development of an aeroplane, showing what evolved from the orginal Avro Manchester, which was designed in outline in 1936. The planforms of the various aircraft in the series are shown and their common derivative is evident. The curve shows how the all-up weight increased; it more than doubled whilst the basic structure remained the same. Each of the aircraft that evolved has given great service and many are still in use. The Manchester itself did not go into service in numbers for a variety of reasons, but it was the essential basis for the Lancaster, which was one of the most successful bombers of all time. It is unlikely that those who placed the order for the original Manchester foresaw what would result from it, but they saw far enough to start the process off. Had they not done so it is unlikely that the rest could have followed, because it is much more difficult to reach a particular point in the evolution directly. When great issues hang on technical superiority, the maintenance of a reasonably steady continuity of development is essential to success.

The great increase in weight lifted by the same basic structure, extended and altered in detail, demonstrates the point that what is found to be possible with detailed development is usually far more than could reasonably be anticipated at the beginning. This is because in any engineering device the ultimate limitations are not usually reached by all parts at once, and relatively detailed changes can greatly increase the capabilities of the device. Furthermore, it is almost always the case that some parts are found in practice to be capable of far more than it would have been prudent to assume at the beginning. Knowledge that this is so presents a problem of great subtlety in design. To what extent in the initial stages should provision be made—and how—for long development? Though this is a problem in all engineering, it is a particularly difficult one in aviation, since the margins between success and failure—in terms, for example, of weight or drag—are often quite narrow. It is on this point that many scientific assessments of projects fall down, for it is not necessarily the design that is thought to be best on immediate criteria that will prove to be so as it proceeds on its evolution. Design is, and is likely to remain, an art greatly aided by science but by no means wholly contained in it, and this is one of several reasons why scientific assessment is not the whole basis for decision.

Fig. 2 shows how the thrust obtainable from a typical jet engine increased with time, and again shows what can be achieved once a device is available for development. The long-term influence of continuity of development is illustrated in Fig. 3, which shows how the weight of engines per unit power developed has fallen with the passage of time. The much more rapid advance of the jet engine compared with the other types reflects the fact that its development has been continuous, and that the resources put behind the task have been great.

It is interesting to consider whether the scope for development in future aircraft and engines will be as great as in the past. At first sight it appears that this might not be so but I think that this is always the case when a radical advance is started. What is true is that as design methods become more exact, so the full potential is more readily achieved at the first attempt. But it is generally the case that, when a radical advance is started, new materials must be used and new constructional methods adopted, so that the accuracy attained in established design arrangements is less transferable than might at first be supposed; as more is learned about the new methods, scope for development again appears.

The time taken to bring a radically new device into being is the sum of these elements; the time for research to reveal the possibility; the time taken to make the decision to attempt to realize the possibility; the time in learning how to apply what is known in the broad to the detail of the particular project, to find out how to make it a practical article and to embody this knowledge in drawings from which it can be made; the time it takes to build the prototype and make it work; the time to produce in numbers. By common consent the total time is getting longer and longer in aviation and, under highly competitive and unsettled international conditions, is becoming too long. I have no easy answer to this but would like to draw attention to one or two points which arise from considering it.

Applicable Research. The broad search for detailed knowledge, from which the possibility of a radical engineering change emerges, is the essential element from which all else springs. There can be little doubt that this "applicable research" is as good an investment as modern society can make. It is usually the case that it proves applicable over a wider field than is ever foreseen; aviation research has been responsible for advances in the properties of materials to an extent far greater than any other industry, and these improvements have benefited engineering at large. Whereas the application of knowledge, when acquired, is a matter of choice, and the exercise of that choice depends on all sorts of factors such as—in aviation—the military threat, the state of the exchequer and the policy of the political party in power, it is almost certain that the chance to make the choice will not be available unless an adequate carpet of knowledge is continuously created. But this does not mean, as some seem to argue, that undirected research should be free of all restraint. Much useless so-called scientific work is done under cover of the idea that anything called scientific research is a good idea. There is no golden rule which enables the right choice of research to be made. It is an essential qualification for those engaged in the direction and administration of research that they should have sufficient awareness of the kind of engineering project that it might eventually become important to attain, and a sufficient ability to foresee applicability of the right kind, to be able to make the right

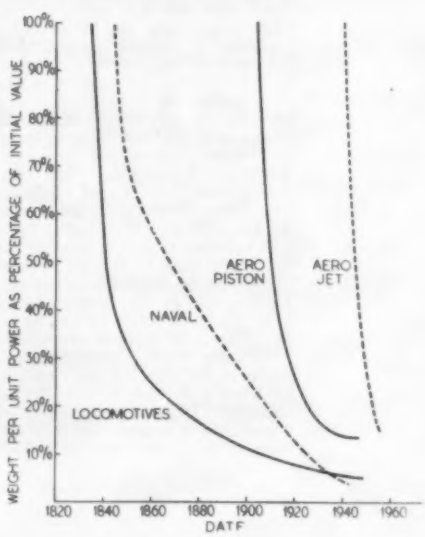


Fig. 3. The influence of continuous development on the specific weight of engines (due to Hayne Constant and reproduced from the proceedings of the Royal Institution 1955).

choice of work. It is a long and difficult process to create really good research laboratories, but they can deteriorate rapidly. Furthermore, they can run down a long way without it being apparent to those who are not skilled in research and its administration.

The fact that aviation has such wide national implications has led inevitably to the creation of large research laboratories operated under the auspices of governments. There have been many experiments made to try to find the best way of operating such places; my impression is that systems under which the establishments are shielded from the direct influence of a government department through the medium of a professionally knowledgeable governing committee reporting directly to a high political level, have much to be said for them. Though the test of the system is whether it attracts the right men, it is also true that the right men will make any tolerable system work. But the applicability of the work done is so crucial an issue in assessing its value that it is essential to create a position of trust and close contact with the industry that makes use of the knowledge and the user who operates the engineering product. There is only one basis on which this position can be created. It is the recognition that the official establishment should not seek to discourage research enterprise in industry in order to keep the work for itself, nor should it attempt to do project work for which the industry's facilities are much more suited. There is a continuous and perhaps natural tendency on the part of the staff of some of these establishments to do both these things. The latter is particularly damaging; not only does it create a suspicion that government sources are attempting to take work from industry, but it aids a tendency in research establishments to "evade the issue," which is to carry out good applicable research. This is not an easy thing to do if project work of a serious kind is allowed to intrude. Such project work creates a flurry of day-to-day executive work which clogs the minds of those who are not particularly suited by training to handle it, and it provides an excuse for not facing the really hard task of breaking new ground. Those who work in a government-operated research unit should seek new applicable knowledge, create the position of trust with industry and users which will greatly aid their assessment of applicability, and recognize that if this is to be achieved, they must not try to do the other fellow's job. They should also recognize that if they do try to do industry's job it is likely that they will not do it well, but even if they do, it is certain to reduce their ability to create new knowledge of the right kind; it is by the applicable knowledge they produce that they will in the end be judged, and rightly so. A few odd per cent of gain should not be the target when means of securing more radical changes is the real aim; it is another excuse for avoiding the issue, but the few per cent—and more—will come in any case from normal development. If the reason people turn to project work is because they can't really do research well, or because they prefer engineering application, then it is better that they should leave the research laboratory and go elsewhere.

Strength of Resources. Few will dispute that the time taken relates directly to the strength of manpower and facilities that is deployed. But this is not to say that there is not ample room for individual brilliance and managerial skill. The evidence that these qualities are at work is, of course, that more seems to come from the resources used than might at first be expected; one has only to examine the facts to be aware that there is a factor of two or three to one in the effective technical productivity of research and design units, and the methods which produce this "gain from nowhere" are of far greater value and importance than most other things in this process. The "strength of resources" argument so overburdens the minds of some who have to decide, that they are apt—and it has happened in England—to "write off" in their minds, and actively to discourage, those places that produce results out of proportion to their apparent strength, on the grounds that they are too small to be able to handle the job. There is a lot to be said for "backing the stable." Much harm is done by too blunt a use of the "number of heads" and the "technical planning" arguments. The fact is that individual flair and method can make a very big difference indeed and it is of great importance to recognize and encourage them. But with a given level of skill time is governed by strength of resources.

A substantial part of aviation research and development is paid for by the State in support of military programmes. In the West the economic system is based on private enterprise and aircraft are supplied in the main by privately-owned companies, with a government department having a good deal to say on what they do. This is an excellent arrangement—the best— but, unless both parties are wise, it is possible to "fall between two stools." It seems to me that the point that is sometimes disregarded is that too great a divorce of authority from responsibility must lead to difficulty. If there grows in the staff of a government department a tendency to assume authority without responsibility, to build up large staffs of only average calibre to exercise it, and to seek to place on industry responsibility without authority, the system will not work well; decisions are delayed or avoided, and morale, enthusiasm and determination, which are the elements essential to the speedy achievement of technically difficult tasks, are depressed.

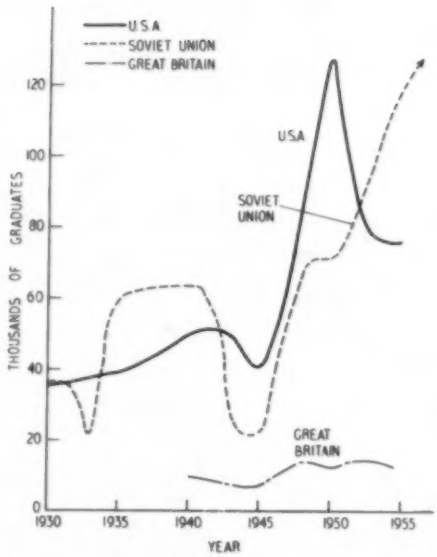


Fig. 4. Graduates in science and technology (for definition of "graduates" see text). This graph is reproduced from the Universities Quarterly, February 1956. The figures for Great Britain are not considered good for comparison (again see text).

I would like to say a word about the British position on resources. The cost of aeronautical equipment, excluding effects of monetary inflation, rose about ten times between the low-subsonic era before the Second World War and the high-subsonic and transonic era after it. The British nation was not in a position at the end of the war to finance immediately all the new resources needed for modern aviation; constructional effort had to go into the building of houses and industrial plant to replace those destroyed by bombing. Whether, in the circumstances, more might have been done is a political question which is not for me to discuss here; the view was that a large aeronautical re-equipment programme could not be started at the time because of the conditions left by the War. The present generation of British aircraft have, therefore, had to be developed without as much benefit as we would have liked from the technical resources which are recognized to be such an immense help in achieving performance and in reducing the time of development. The critics of the British industry both at home and abroad—and there have been some in U.S.A.—have perhaps forgotten that notwithstanding these difficulties the present generation of British aircraft and engines are as good as, or better than, their competitors to the extent that the world outside Britain is buying them at the rate of 300 million dollars worth a year, and during the period in question the gas-turbine-propelled civil airliner, in both the jet and propeller form, has been added to the already long list of engineering firsts which came from Britain. That there is room for criticism of the position I would not deny; I don't know how people can attempt, and achieve, difficult tasks in difficult circumstances without being open to comment. The more curious situation is the one in which everything appears to be so good that nobody wishes to suggest that it might be improved. But the task of the genuine critic in aviation is not easy because the subject is complex. I cite an example later—the breaking of the world's speed record calls for much more than speed; similarly, military and civil aircraft are not adequately assessed on a single performance parameter. Aeronautical resources in Britain have now improved considerably; in the last five or six years it has been possible to make a large investment in equipment both from national and private funds and this should have a significant effect on British development in the next decade.

One of the big factors in resources is technical manpower. This has been talked about a good deal in recent times, and I think that the heart of what has been said is contained in Fig. 4 (reproduced by the courtesy of Lord Simon and the *Universities Quarterly*). Figures such as these can be misleading because the definition of a graduate varies from country to country. The figures for Great Britain are not comparable with the others for this reason; in Great Britain substantially more people come into technology through non-university channels than through the universities, and many of these people would count as graduates in U.S.A. or

U.S.S.R. Nevertheless, too few able young men and women come into science and technology in Britain and probably in U.S.A. Undoubtedly one of the factors at work, anyway in Britain, is the feeling that science and technology are "slightly odd." My own view is that there is no particular virtue in being a scientist, but neither is there a virtue in not being one; it is on the latter point that there is controversy, for some people still seem to think that there is. Such views should now disappear and science and technology be recognized as neither odd nor particularly virtuous, but as an essential element of modern society, capable of great influence and service. Centres of learning would act wisely by embracing them fully rather than, as has regrettably been the case, making them a matter for argument instead of action.

It is often interesting, and sometimes moderating, to look back on what has happened before. On doing this in the matter of scientific education and training I find that over one hundred years ago, in England, there was a great outcry that there would be a disastrous shortage of scientists, and the terms used were very similar to those employed in the current argument on the matter. The present position is not new! But it was this outcry of more than a century ago that made England a considerable pioneer in scientific and technological education, and this effort served her well. Now many steps are again being taken in Britain, and one of the most interesting is the creation of a fund to which all British industry is invited to contribute (and has already done so to the tune of many millions of dollars) for the purpose of creating, in the best schools in England, scientific laboratories and libraries worthy of the place that science should have in school education.

There is, I think, one matter which comes out of an examination of the Russian position in aviation that bears on the subject of strength of resources, and on the subject of the next section of this paper (Decision and Scientific Criticism). Fig. 5 contains outline drawings of a variety of Russian aircraft. [Sir Arnold showed three-view drawings of the Mig-17, Super Farmer, Super Flashlight, Badger, Bison, Bear, and one of the Sukhoi supersonic deltas. These drawings were reproduced—with due acknowledgment—from *Flight* of August 3 last.] Until the point marked "first break" [the delta] Russia has supplied all her military and civil needs on one basic aeronautical formula—sweepback and boundary layer fences—and in addition there has been a considerable consistency in tailplane arrangements. (There are several other Russian types, in addition to those shown, based on the same formula.) This means that the basic data on the configuration, and experience from any aircraft in flight, was readily transferable from one to the other. The economy that this represents is considerable, and goes some way to account for the rapid growth of Russian air power. When the first break was made, it was presumably because the formula was thought to be exhausted in that the aerodynamic demands arising from increasing supersonic Mach number had stretched the structural problem far enough to justify turning to the stiffer delta planform; but the tailplane arrangement was not changed and there was thus some continuity of experience brought into the new formula.

To secure the benefits that arise in this way, certain penalties must, no doubt, be incurred. A great burden is placed on the machinery for making the decision because, if it is wrong, the consequences are severe. But this burden is less than might be supposed to this extent: provided sufficient work has been done on the fundamentals of the arrangement chosen to eliminate any possibility of a radical difficulty then, given determination, the arrangement can be made to work. It may not be ideal in some circumstances, but departure from ideal is presumably thought to be justified by the gains in other directions.

Decision and Scientific Criticism.—Decision must take account of a good balancing of time and technical risk; must recognize that a good deal of technological information vital to the success of a project cannot be obtained until the project is started because, before that, the need for it is insufficiently pointed; must have regard for the vital part played by development, and the need to provide a basis from which it can begin.

Scientific criticism has become a considerable factor in decision in recent times, and quite rightly so; but there are dangers that must be recognized. First, the scientist, as he is at present educated, is endowed with a technique of analysis which is assumed to be logical—but he is not necessarily endowed with initiative, inspiration and courage. There are some who argue that a scientific education of the kind now common has a positively adverse effect on these qualities; I doubt if this is so, but it does not do much to encourage them. The point of danger is this. Most scientists are educated in a way that gives them a considerable faith in the logic of their discipline but little idea of its limitations and how to overcome them. Belief in its accuracy is right provided the basis from which the deduction starts is full and complete, but when decision must be reached in a situation of any difficulty, it is rare that a complete basis for subsequent scientific deduction can be stated. Because there are always imponderables, scientific assessment can be misleading unless it is moderated by a reasonably full understanding of the processes of application and what can occur in them. Most courses of study in science—and many in engineering—leave this matter quite out of account. It has been the pose of many academic men whose disciples are in the humanities that their students are not concerned with any vocational aspect of their studies. Yet what greater contribution can an educated mind make to life than by application through a vocation and how many do not, in fact, apply it this way? Equally, many teachers of science take the view that their students are concerned only with the purity of a line of scientific thought, untrammelled by considerations of application. It would be better if the study of a section of the history of science and of the history of some engineering developments were regarded as essential in the preparation of any student of science or engineering, and if some study of the methods of application was also seriously made. Anyone who studies the history of science will soon be convinced that its progress, far from being highly logical, has been just the reverse. The reason it appears to be logical is only because it is taught that way; it is convenient to remember only the work that was later seen to fit to the logical pattern. But an examination of the fine structure of the history of science very quickly shows that scientific evaluation of the next move does not necessarily get the only, or even the ultimately right, answer.

Scientific evaluation is an essential part of the process leading to decision, but scientific people concerned in it too often take less account of the other parts of the process than they should; they are sometimes under-equipped in their feeling for the ultimate consequences of the influences they have felt themselves forced to neglect. When progress in the acquisition of knowledge is rapid, it is easy to advocate that decision be delayed because something new is about to be found, or that a project be stopped because something better is now possible. It is also easy to state a case for a large number of variants on any theme. These are serious difficulties which undoubtedly contribute to the length of time taken to bring scientific possibilities to practical use. There is no escaping that, unless enormous resources are to be deployed, this position must be firmly controlled by decision that has regard for the great investment in technical effort that each individual project represents, and for the necessity, in times when technical superiority matters, for reasonably continuous development of "hardware" as well as of concepts. If scientists use their formidable techniques of analysis to do no more than delay decision by arguments on marginal points, and fail to study and take account of the other issues, or if they advocate indiscriminately too many variants on the theme, they do less service than they could or should.

The System Concept.—One of the factors that has had an adverse effect on the time taken to achieve aeronautical developments is the "weapon system concept." No reasonable person can think that a weapon should be other than a system designed to produce the end-result desired; this is just as true in civil applications. But, under the cloak of a term such as "weapon system," project planning can go adrift and I think has done so in more than one case. There are many elements in any weapon: for example, in a fighter, the airframe, the engine, the radar, the armament—and they must operate together harmoniously. But if a high level of technical risk is taken in the choice of each of these elements, then the burden of the technical work needed to bring them all along to the same end point is very great indeed—if all the babies were born on one day there would be a shortage of midwives. Yet this is what has sometimes been advocated as necessary to a "weapon system." The practical difficulties soon become almost overwhelming—the designer of the wing wants to know the aerodynamics and loads of the weapons he must attach but these are not yet fully designed; later the weapon must be changed due to development snags but this means changes in the wing when the jigs are completed and metal committed to them. This situation is multiplied many times over in a complicated system. If a new project is to come through reasonably quickly it should be so conceived initially that the various elements that make it up are not all at the same state in their evolution development. There cannot be any doubt that to produce a sound product extensive jigging and tooling is necessary, but I am inclined to wonder whether it is sometimes taken too far. At a time when technical superiority may well be all important, the production engineer is presented with an opportunity to make what can be a vital contribution by achieving the maximum flexibility in his position. The methods adopted in the West and in the U.S.S.R. are in contrast; the Russians appear to use far less jigging and tooling than the West, and they no doubt pay some penalty in the maintainability and performance of the product and in the manpower used to make it, but they probably gain in time and in ability to make change to an extent that justifies this position in their eyes. Research and development is as necessary in production methods as it is on the technical side of the aircraft; the creation of a position as receptive as possible to the most up-to-date technical requirement must take a position of importance alongside the achievement of rapid, accurate and cheap output.

(*To be continued*)

TALKING ABOUT ROCKETS

Eighteen Nations Represented at Rocket and Missile Conference in Paris

THE last of this year's succession of international rocket meetings was held in Paris from December 3 to 8 at the Ecole Supérieure Nationale de l'Aéronautique, under the auspices of A.E.R.A. This is the first attempt by the Association to hold a congress on guided missiles, although it has been responsible for the presentation of four international congresses during the last five years on associated aeronautical subjects.

It may be fairly said that the Congress achieved a limited success and may be likened to the proverbial curate's egg. An international flavour was maintained by the presence of delegates from eighteen different States including Mexico, Yugoslavia, Turkey, the U.S.S.R., and Poland, as well as Western European countries. However, as the whole proceedings (with few exceptions) were conducted throughout in French without interpretation many foreign delegates remained rather in the dark as to what was going on. Inevitably the attractions of Paris and the programme of visits to various firms arranged for the Congress took a toll of audiences in the lecture hall. That this has been a marathon year in the field of guided missiles meetings was also evidenced by the fact that of the four hundred or so delegates listed to attend, barely two hundred were present for any length of time. This was also due in part to an apparent boycott by the Americans, who for once did not predominate, and by French industry itself. The president of honour of the Congress was M. Robert Esnault-Pelterie, known for his own early pioneer work in the aeronautical field, and others present included Dr. Eugen Sänger, Professor A. Blagonravov of the U.S.S.R. Academy of Sciences, Col. P. C. Gaudillère, and Mr. M. Golovine of the Hawker Siddeley Group. The Ministry of Supply was represented by Dr. Dorling, Lt-Cdr. F. R. J. Spearman and Mr. J. J. Gait; Mr. D. C. Mandeville represented the Ministry of Defence. Several representatives of British industry and the technical Press were also present.

The Congress programme was arranged in three parts, running concurrently: the presentation of papers, a series of external visits and an exhibition. Lack of support was most evident at the exhibition, which did not open until late in the week and could boast only one guided missile, the Oerlikon surface-to-air weapon, now quite a veteran of such occasions. The only other foreign company was Solartron, the British electronics firm. The remainder of the stands were taken up by a few French firms with displays of alloy steels and heat resistant metals, some electronic computors, accumulators, and a display of modern pilot oxygen equipment by the Air Medical Research Centre of the Armée de l'Air.

Points from the Papers

Sixty-eight papers and accompanying films were presented in ten morning and afternoon sessions. Some of the papers were inevitably repetitions—slightly rehashed in some instances—of previous presentations by the same authors. Others, more or less competent, were general in nature. One such, by Dr. William C. Hodgson and J. C. Ryan (U.S.A.), on missile guidance systems, was very comprehensive; but although inertial guidance systems were mentioned the reference was not expanded to include comments on the current problems of component accuracy with these systems.

Of the four British contributions, "The Raven rocket and upper atmosphere research," read by Dr. Dorling, and "Project Gassiot and the International Geophysical Year," read by Mr. Mandeville and being an outline of the intended British participation in International Geophysical Year activities in this sphere, aroused the greatest interest. Mr. Mandeville intimated that, although static tests of Raven had been successfully carried out, the first powered flight trials had been postponed to the early part of next year, owing to renewed difficulties. It was anticipated, however, that the rocket would be ready in time for its intended use in the I.G.Y. programme.

A paper which merits attention was one of several presented by Dr. B. Winandy, entitled "Underground logistics of missile bases." Taking as his axiom that the "atomic age" will also be the "underground age," he discussed the economics and comparative logistics of surface installations with their necessary protection compared to that of underground launching, storage and assembly chambers for rocket missiles, together with factories and workshops, underground connections and all the associated power facilities. In the latter connection he mentioned Camille Rougeron, who has posed the interesting theory of utilizing the earth's natural heat for such purposes by driving a shaft to an immense depth and then detonating a high-explosive charge, this being followed by a thermo-nuclear charge. The immense cavity thus formed would then be flooded immediately with water. Rougeron estimated that the resultant production of steam would be sufficient to drive the turbines of a power-station for seven years or more. This would cut out the use of any surface resources for the production of power.

Another interesting paper was "Hydro-rockets for underwater propulsion," in which G. Partel of the Italian Rocket Society described some work he did on the design of a rocket motor (PX-5) and an underwater missile (the U-6) powered by this motor, which is driven by the production of hydrogen and steam from the combination of sea water and a suitable reagent, in this case boro-butane B_4H_{10}. The thrust was given as 660 lb/sec and duration of thrust as 1,000 sec. The missile in which the PX-5 was to be fitted was designed to have a weight of 1,000 kg with a 300 kg warhead, and was to be guided. The advantages of this type of missile were claimed by the author to be simplicity of construction and low cost. A prototype PX-5 motor was actually tested on a motor boat. This engine was developed from the original experimental model, the AD-2, which used a sodium/potassium eutectic as reagent with the formula N_2Na, containing 22.75 per cent sodium by weight. The reaction equation was given as:—

$$2K_2Na + 6H_2O = 4KOH + 2NaOH + 3H_2 + 267 \ Kcals.$$

The duration of thrust of this motor was 50 sec and it had a specific consumption of combustibles of 5.1282 kg/tonne-sec and total impulse of 58,300 kg.

Also in the propulsion series was a paper by R. E. Small of the General Electric Co. (U.S.A.), in which he described that company's X-405 motor, for the propulsion of the first stage of Project Vanguard, the earth-satellite vehicle. The X-405 has a thrust of 12 tons and a thrust duration of 150 sec, yet weighs only 496 lb. Sectioned views of the motor were shown and an indication was given of the difficulties of constructing a motor in which temperature variations between −170 deg and +2,750 deg C occurred within a distance measured in centimetres.

Another American paper described the SPARK Programme (Special Project, Altitude Rocket Knowledge). This is a unique I.G.Y. venture by the Rocket Research Institute, a non-profit organization founded in 1943, for which they have established a new section in Sacramento, California. The SPARK Programme is one of non-military applied research designed to give engineers, laymen and students a practical working knowledge of rocket propulsion and related sciences by the construction of an intermediate altitude sounding rocket for the I.G.Y. The Spark I system actually consists of two rockets, a 350 lb thrust, 85 sec duration, liquid-oxygen/alcohol sustainer rocket, and a 5,000 lb thrust, 1 sec duration, solid propellant booster rocket. Calculations indicate that the liquid sustainer will be able to carry instruments to altitudes above 100,000ft.

The Soviet Contribution

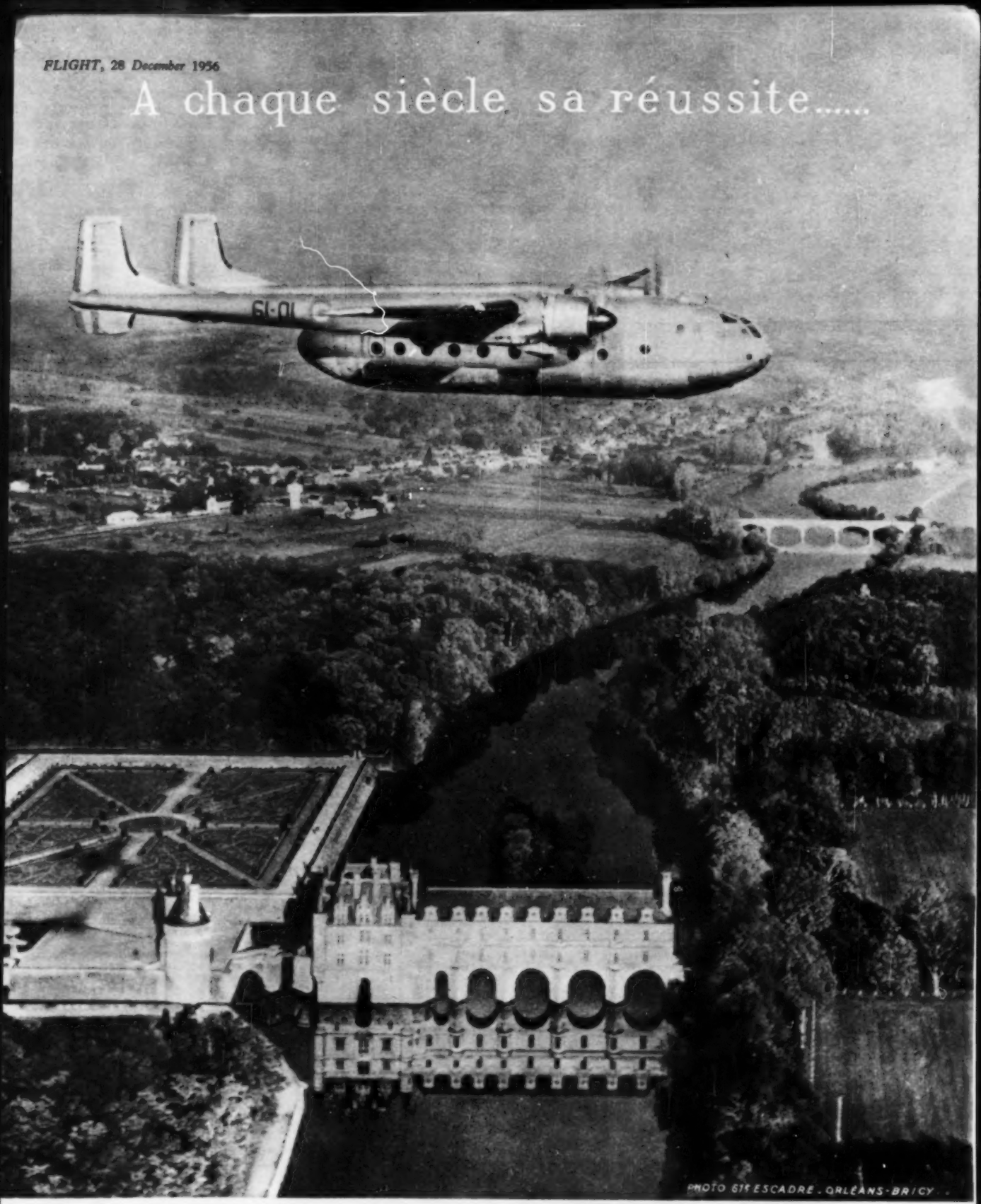
In keeping with what now almost amounts to a tradition, the Soviet delegation of ten arrived late. Nevertheless the papers presented by two of their members were significant not only for their origin but for their content. Professor Poloskov, a member of the Institute of Geophysics in the Academy of Sciences of the U.S.S.R., in his paper on "The study of the upper atmosphere with the aid of rockets at the Academy of Sciences, U.S.S.R.," outlined the Soviet programme for participation in the exploration of the upper atmosphere during the I.G.Y. This indicated that the subjects of the experiments were similar to those of Western countries, that is, the composition of the upper atmosphere, temperatures and pressures, ionosphere, mesons, solar effects and upper air currents. Results are to be obtained directly by sounding rockets and indirectly by ground observatories and analysis and both methods correlated. The programme calls for rocket soundings up to an altitude of 1,000 km at various geographic points on the same latitude for solar studies, study of mesons, the earth's magnetic field, meteorites, etc. Radar and optical studies of meteorites are also forecast.

The study of the atmosphere's composition at 80-95 km has already commenced, he announced, with the firing of sounding rockets from which two containers weighing approximately 250 kg each were ejected at the desired altitude by mortars fitted to the rockets. The lower portion of each container was hermetically sealed, and contained the programme mechanism, batteries, clocks, a special camera with motor, and other instruments. To the bottom was fitted a spiked cone which penetrated deep into the earth on landing and maintained the container in a vertical position. The upper portion was open to the ambient air and contained glass spheres, varying in capacity from 3 cu cm to 500 cu cm. The glass spheres were fitted with admission cocks which opened and closed automatically at the desired altitude. The containers themselves consisted of metal cylinders about 2 m long and 0.4 m in diameter. To the top of the containers was also fitted the parachute in an hermetically sealed sheath. The parachute was automatically ejected at a height of 10-12 km, at which height it opened itself. By ejecting the containers clear of the rocket before sampling the atmosphere the exhaust gases were avoided; and by regulating the admission cocks so that they opened when the containers were approximately at the top of their trajectory and thus not exceeding a speed of 50-70 m/sec the interior pressure corresponded well to the exterior pressure. No mention was made of diffusion difficulties with the samples. Results obtained of atmospheric pressures at altitudes from 50-110 km were said to agree approximately with those known to have been obtained in the U.S.A.

The determination of wind speeds and direction at altitudes from 60-80 km had also commenced, using similar containers from which five smoke cylinders were ejected to explode simultaneously at varying altitudes, each forming an artificial cloud. The clouds were filmed with kine-theodolites. Variations in wind speeds were found to be great but were always high, being of the order of 60-100 m/sec. The wind directions were found to vary seasonally, being from east to west in the summer and from north to south in the winter. This method was found to be satisfactory up to an altitude of 80 km, above which the smoke particles could not maintain themselves. No mention of the rocket vehicles was made by either of the Soviet lecturers and questions on this point were blandly turned aside by a profession of ignorance on this point as not being their speciality—a more diplomatic procedure, perhaps, than the blunt American refusal to answer anything that might appear to infringe security. Nevertheless the payload of the rockets

(Concluded at foot of page 1004)

A chaque siècle sa réussite.....



S.N.C.A.N

Société Nationale de Constructions Aéronautiques du Nord

2 à 18, RUE BÉRANGER - CHATILLON - s/s - BAGNEUX (SEINE) FRANCE Tél. ALÉSIA 57-40

Our best wishes for 1957 to our friends all over the world

used by air forces of twenty-seven nations

The many superior patented design features of the Martin-Baker Light-weight FULLY AUTOMATIC Ejection Seat, combine to make it the finest piece of equipment of its kind in the World.

Martin-Baker

aircraft · company limited

ENGLAND & CANADA

Short 184 with 250 h.p. Rolls-Royce engine.

THE SHORT SEAPLANES

HISTORIC MILITARY AIRCRAFT No. 14 PART 3 By J. M. BRUCE, M.A.

THIS article continues Mr. Bruce's study of the classic series of Short seaplanes. Part 1 was published in our issue of December 14, and Part 2 last week. The author acknowledges his indebtedness to Mr. Bruce Robertson, who provided much of the information relating to serial numbers, and to Mr. H. H. Russell for some of the facts on which the history is based.

THE first Short 184 appeared early in 1915. Its structure was typical of the period: the fuselage was a wire-braced wooden box-girder covered with fabric, and the wings were also of fabric-covered wood. The tail unit embodied the characteristic large fin which had appeared on the earlier Folder and Types 135, 166, 827 and 830, and a balanced rudder was fitted. The main floats were large wooden pontoons, transversely connected by arched cross-bars which held the torpedo crutches; the tail float was likewise of wooden construction and had a water rudder; there were stabilizing floats at the lower wing-tips. The engine was fully cowled and a large box-like radiator was mounted above it.

The wings could be folded, and in their folded position the tailplane lay in the outermost bay of the mainplanes. This fact accounts for the peculiar arrangement of the landing wires in that bay: they were caught up by other cables from the upper ends of the outer interplane struts so that they did not foul the tailplane when the wings were folded. A short horizontal strut projected on either side of the fuselage just in front of the forward tail-float attachment strut; this strut engaged the base of the centre rear interplane strut on each side when the wings were folded. In its original form No. 184 had ailerons on the upper wing only; these were single-acting surfaces, and hung down limply in the absence of any supporting airstream. They were later fitted with a balancing cable but apparently proved to be inadequate for maintaining lateral control, for ailerons were fitted to the lower wing also. All the production Short 184s had ailerons on upper and lower wings.

Production was ordered on a fairly large scale. After the first small batch of ten (841-850) had been ordered from Short Brothers, other contracts were placed with S. E. Saunders, Ltd. (8001-8030), Short Bros. (8031-8105), Mann, Egerton and Co., Ltd. (8344-8355), the Westland Aircraft Works (8356-8367), the Phoenix Dynamo Manufacturing Co., Ltd. (8368-8379) and Frederick Sage and Co., Ltd. (8380-8391). With the exception of the Saunders company, the orders for Short 184s marked the entry into the aircraft industry of the firms concerned, all of whom had been asked by the Admiralty in the spring of 1915 to undertake the manufacture of aircraft. Fortunately the Short 184 was not a complicated aircraft and its manufacture was relatively easy; nevertheless it was no mean feat for firms such as Mann, Egerton and Frederick Sage, who had no aircraft experience, to complete their first Short 184s within three months of signing the contracts: the first Sage-built machine was completed late in September 1915 and the first Mann, Egerton Short emerged in November. Westland commenced deliveries in January 1916, Phoenix in the following month.

On May 21, 1915, the seaplane carrier *Ben-my-Chree* sailed from England under Sqn. Cdr. C. J. L'Estrange Malone, bound for the Dardanelles "with the unofficial intention of torpedoing the *Goeben* and the *Breslau*." The *Ben-my-Chree* had been a passenger vessel on the Liverpool-Isle of Man service before her conversion into a seaplane carrier. She had a speed of 22 kt (though Cdr. Samson claimed 26 kt) and could accommodate three Shorts and two Sopwith Schneiders. When she arrived at Iero Bay, Mitylene, on June 12, 1915, she had on board the first two Short 184s to be built. Exactly two months later one of the *Ben-my-Chree*'s Shorts made history as the first aircraft to sink an enemy vessel with a torpedo.

On August 12, 1915, the *Ben-my-Chree* was in the Gulf of Xeros, and a Short 184, piloted by Flt. Cdr. C. H. K. Edmonds was sent off across the Isthmus of Bulair to attack an enemy supply ship which had been observed off Injeh Burnu. Edmonds flew without an observer; his Short carried fuel for only 45 minutes flight, yet he could get it to climb no higher than 800ft. Gliding down to within 15ft of the water, Edmonds released his torpedo at a range of 350 yd and hit his target amidships; as he flew away he could see the Turkish vessel settling by the stern.

Edmonds' achievement was robbed of some of its lustre when, after study of reports from British submarines, it was learned that the ship had been torpedoed and shelled four days previously by the submarine E.14 and had been left beached in

Short 184 Type D (single-seat bomber version).

THE SHORT SEAPLANES . . .

shallow water. Nevertheless, the significance of his action was in no way diminished, for he had conclusively demonstrated that it was possible to drop a torpedo from an aircraft and strike a selected target.

If proof were needed it was provided five days later, when both Short 184s of the *Ben-my-Chree* sank an enemy vessel. The official report of the action is as follows:

"Seaplane reconnaissance had revealed that Ak Bashi Liman, on the Gallipoli Peninsula, just above the Narrows, was being used as a base where the enemy unloaded his supplies, which came by water in transports. It was planned to attack the transports with torpedoes.

"The Ben-my-Chree arrived at the same position as on August 12th, just before dawn. Two seaplanes were hoisted out, with the same load as on the 12th, piloted by Flt. Cdr. Edmonds and Flt. Cdr. G. B Dacre, D.S.O.

"The scheme was to climb to about 1,000ft. across the Isthmus of Bulair, and over the enemy aerodrome at Galata, hoping to get past the latter place unopposed, as it was still not quite daylight. Thence to fly down the Straits at low altitude to Ak Bashi Liman, where it was thought that we should be mistaken for Huns. The machine would be approaching the direction of the Galata aerodrome, and would be difficult to recognize flying at low altitude from the sun and against a background of hills.

"This worked perfectly as regards Flt. Cdr. Edmonds' machine.

"At Ak Bashi Liman he fired at an unbroken target presented by three steamships at anchor, and hit the middle one.

"An agent's report subsequently showed that she was gutted by the ensuing fire, but the hull was salved and taken to Constantinople.

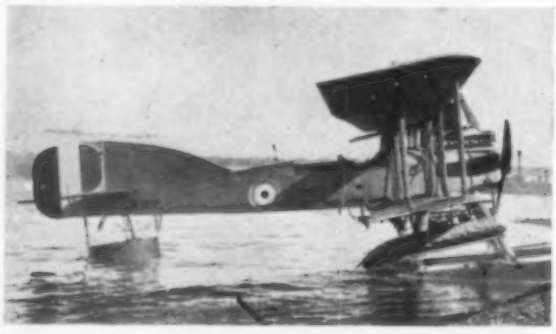
"No opposition was experienced except rifle-fire at Bulair, and some sniping after the torpedo was fired.

"Flt. Cdr. Dacre had engine trouble, and was forced to descend in the Straits without reaching Ak Bashi Liman. He saw a steam tug on the Asiatic shore, taxied in, and torpedoed it whilst under rifle-fire, and then taxied away towards Bulair. His engine developing a few more revolutions, so he managed to get off, and crossing Bulair at about 200ft, reached the ship.

"In that climate it required a nearly new machine to lift the torpedo, and unfortunately lack of such new machines prevented the attacks from being repeated.

"Otherwise, by seriously interrupting the Turk's maritime communications (about one-third of his supplies) the torpedo seaplanes might have largely affected the campaign."

As indicated in the penultimate paragraph of that report, a flight with a torpedo in a hot climate taxed the Short 184 to the uttermost. No observer could be carried; the limitation of fuel to what sufficed for only 45 minutes' flight placed a severe restriction on radius of action; and wind and sea conditions had to be exactly right. After those early successes no other torpedo attacks



Production Short 184, with 240 h.p. Renault engine.

Robey-built Short 184 with Scarff ring.

Mann, Egerton Type B seaplane.

were made by Short 184s in any theatre of war, and the type completed the greater part of its operational service as a patrol seaplane and bomber. Experiments with torpedoes continued, however, and Short 184s participated in them; the seaplanes were also used to train pilots in torpedo-dropping. Nevertheless, the introduction to A.P.1344 lamented: "The development [of torpedo aircraft] has been astonishingly slow, when it is considered that there are no really great technical difficulties, and it was merely necessary to adapt a modern naval torpedo to a suitable modern aeroplane."

What was perhaps not fully appreciated by those so close to the events they chronicled was that a truly "suitable modern aeroplane" did not exist before the advent of the Sopwith Cuckoo landplane. The seaplanes were too dependent on ideal weather conditions and (originally at least) had too marginal a performance to permit the sustained and energetic pursuit of a series of experiments. One of the Shorts used in torpedo experiments at Felixstowe had its rear cockpit faired over.

But if it did not again do battle as a torpedo-carrier the Short 184 gave a good account of itself otherwise. Those of the *Ben-my-Chree*, again piloted by Flt. Cdr. Edmonds and Flt. Lt. Dacre, flew 120 miles (of which 110 were over land) to bomb the railway bridge over the Maritza south of Kuleli Burgas on November 8, 1915. Each Short carried two 112-lb bombs; none hit the bridge, but the permanent way was damaged.

In May, 1916, command of the East Indies and Egypt Seaplane Squadron was taken over by Cdr. C. R. Samson. His command included the *Ben-my-Chree* and two smaller vessels, *Raven II* and *Anne*; these carriers had respectively four, two and one Short seaplanes, but it is uncertain whether all were Short 184s.

Samson promptly set about learning to handle the big Shorts and personally flew them on several sorties. He had an early introduction to the fragility of seaplane floats of the period, for on May 22 he was hoisted out on to a heavy sea, intent upon reconnoitring Jaffa, when one of the floats collapsed. Samson and his observer, Capt. Wedgwood Benn, had to swim for it, and the Short sank before it could be retrieved.

Samson has left the following description of the difficulties attending the operation of Short 184s in a hot climate*:—

"I must inform my readers that we generally carried the 16-lb bombs loose in the passenger's seat. I leave to the imagination the job the observer used to have. He was in a restricted space with a Lewis gun hitting him in the neck every time he moved, nursing a camera on his knees, with three or four 16-lb bombs somewhere loose at his feet. Somewhere handy he had to have a pair of binoculars, writing-pad, map, and pencil. . . .

The pilot, on the other hand, on one of the old Shorts in hot climates had no joy-ride. He had generally a really hard time. First coaxing, or most probably forcing, the seaplane off the water, he then had a tough job trying to make the machine climb in the gradually increasing heat of the atmosphere with the water in the radiator on the verge of boiling. He had to keep the engine at practically full revolutions the whole time to have sufficient power to maintain his meagre altitude, and to have some sort of control in the fierce remous that constantly were encountered. At the same time he had to seize every chance, when he gained a few hundred feet, to throttle down."

It was typical of Cdr. Samson that he should try to improve the Short 184's performance. To quote him again†: "I cut off a good deal of the lower plane, and poked about in other ways, converting one of the old ones into a better performer than a new one. I gained six knots in speed, and about 15 per cent in climb. We termed this altered seaplane the 'Experimental Short'."

This modified Short lasted until March 1917, when its floats gave way and it sank.

In European waters, carrier-borne Shorts of H.M.S. *Riviera* and *Engadine* operated against the enemy coast during the winter of 1915-16, but their efforts were hampered by frequent engine trouble.

The Westland-built Short 184 No. 8359 gained the distinction of being the only aircraft of any type to participate in a major naval action during the war. On May 31, 1916, the Grand Fleet put to

*"*Fights and Flights," pages 306-307.* †*Ibid., page 337.*

sea to engage the enemy off Jutland, and Engadine sailed from Rosyth with the Battle Cruiser Fleet. H.M.S. *Campania* should have sailed from Scapa Flow with the Grand Fleet but, although ready to sail, she did not receive her stationing and timing signal, and did not leave until 2½ hours after the flagship *Iron Duke* had sailed—so late, in fact, that she was ordered to return to port.

At 2.20 p.m. the light cruiser *Galatea* signalled 'Enemy in sight,' and twenty minutes later Sir David Beatty ordered *Engadine* to send a seaplane to scout to the north-north-east. At 3.08 p.m. Flt. Lt. F. J. Rutland and his observer, Assistant Paymaster G. S. Trewin, were airborne in No. 8359, and in the course of a 40-minute flight sent back four messages before a petrol pipe broke and compelled the Short to come down on the water. Rutland repaired the fracture with a piece of rubber tubing torn from his life-saving waistcoat but, upon reporting his readiness to continue, was told to return to *Engadine*. As it happened, the flight did nothing to assist the ultimate victory, for *Engadine* was unable to pass the messages on to Sir David Beatty.

In the days immediately preceding the Battle of Jutland, several take-offs from *Campania's* flight deck had been accomplished by Sopwith Baby seaplanes, using wheeled trolleys under the floats. On June 3, 1916, a Short 184 was flown off in similar fashion, but this practice was not developed.

Short 184s continued to be used from the early carrier vessels, and they were also employed on an ever-increasing scale as patrol and anti-submarine aircraft from many coastal stations. Several U-boats were attacked and many bombs dropped close to them. It seems that no enemy submarine is positively known to have been sunk by a Short seaplane, but N.1613 from Bambridge must have come very close to doing so on October 18, 1917: after striking a surfaced U-boat with a 100-lb bomb, Flt. Cdr. McLaurin and his observer saw their target submerging with a 30 deg list to port. The submarine was not seen again. But if no spectacular successes can be attributed to the Shorts, there can be no doubt that their activities were a considerable deterrent to the enemy submarines. Engine trouble was not an unknown feature of these patrols, and on two occasions the crews of Short 184s were taken prisoner by the U-boats they were hunting.

By this time a number of improvements had been made to the Short 184 design, and production had been extended to other manufacturers. A fairly early modification was the experimental installation in No. 8104 of a 250 h.p. Rolls-Royce engine of the the type which was later known as the Eagle. The taller engine had a rather bulky cowling; side radiators were used and there were two exhaust stacks. This variant was not built in quantity.

A single-seat bomber version of the design was built under the designation Short 184 Type D. Powered by the 225 h.p. Sunbeam, the Type D was flown from what would have been the rear cockpit and had internal accommodation for nine 56-lb bombs. No production was undertaken.

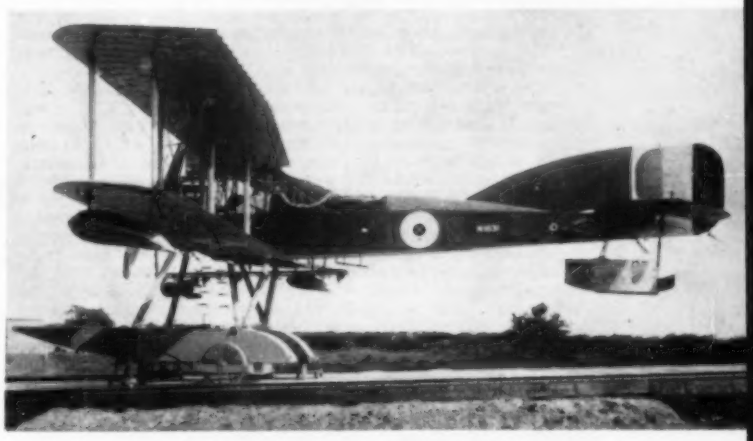
After the Shorts ceased to be regarded as torpedo-carriers, straight cross-bars were fitted to the floats. A somewhat remarkable modification made to No. 8105 was the fitting of an unusually tall undercarriage which yet retained torpedo crutches. The object may have been to minimize the likelihood of propeller damage in rough water.

When Scarff ring-mountings became available they were fitted to many Short 184s, but some machines are believed to have had the Whitehouse mounting; external bomb racks of characteristic form were carried below the fuselage. Some of the firms of contractors introduced minor modifications of their own: if official reports are to be believed, aircraft built by different firms differed in dimensions by an inch or two. As production expanded, contracts were given to Robey and Co. of Lincoln, J. Samuel White and Co., Ltd., the Brush Electrical Engineering Co., and ultimately to the Supermarine Aviation Works, Ltd. Additional orders were placed with all the original contractors except Westlands. Some of these new contractors followed the example of their predecessors and introduced small modifications in the aircraft they built.

Mann, Egerton and Co. built a small batch of a modified version of the Short 184, in the design of which they claimed to have had a hand. To the firm the standard Short 184 was known as the Mann, Egerton Type A, and the modified machine became their Type B. This variant had wings of unequal span, the enormous extensions of the upper wings being copiously braced by cables. The flying wires to the extensions were caught up by auxiliary cables from the upper ends of the outer interplane struts; this was done to prevent the flying wires from fouling the tailplane when the wings were folded. In all other major respects the Mann, Egerton Type B resembled the Short 184, but the 225 h.p. Sunbeam engine was mounted a little higher, thereby raising its thrust line to compensate for the slightly higher position of the centre of drag. Ten Mann, Egerton Type B seaplanes, numbered 9085-9094, were delivered in 1916. Some official references couple these serial numbers with that of No. 8070, which was a Short-built 184; the Mann, Egerton Type B may not, therefore, have been wholly original.

The Short 184 No. 8076 was used to test an experimental device for lateral control. Martin stabilizers, acting upon horn-balanced ailerons, were fitted to the upper wings; in shape, though not in action, they resembled the lateral control surfaces of the James V. Martin K.111 scout which was built in America in 1919. It appears that deflection of a stabilizer caused a righting movement of the ailerons, thereby correcting the aircraft attitude. It is not known whether the Martin stabilizers were successful, but it seems probable that something to make the controls lighter would have been welcomed by Short pilots, for in his recent book *First Through the Clouds*, Mr. F. Warren Merriam has written of ". . . long, thankless patrol flights in Short seaplanes, which were so tiring to handle in rough weather."

A Robey-built Short 184 with 240 h.p. Renault engine, seen with wings folded and on beaching trolley.



Phoenix-built Short 184 (240 h.p. Renault), showing modified wing-tip floats.

Later production Short 184s were fitted with more powerful engines. The Sunbeam was developed to give progressively 240 and 260 h.p., and the 260 h.p. engine was the ultimate power unit. Many Short 184s had the 240 h.p. Sunbeam, and large numbers were built with the 240 h.p. Renault engine. The Shorts with 240 and 260 h.p. Sunbeams could be distinguished from the 225 h.p. version by the presence of a large central exhaust stack just in front of the box-like radiator. The cowling lines were slightly different and, on the 260 h.p. engine at least, a four-bladed propeller was fitted.

The 240 h.p. Renault was sometimes referred to as the Renault-Mercédès engine, not because of any apparently impossible collaboration between the Renault and Mercédès companies but because the cylinders embodied a number of features characteristic

Production Short 184 with 260 h.p. Sunbeam engine.

THE SHORT SEAPLANES . . .

of contemporary Mercédès practice. Some of the early Short-built Renault 184s had their radiators disposed in two elements, one on either side of the fuselage, but the majority of the aircraft reverted to having the clumsy box-like radiator above the fuselage. All the Renault Shorts had a single central exhaust stack of slightly different shape from that fitted to the Sunbeam-powered machines. A more positive means of identifying the Renault engine was its right-hand propeller: all the Sunbeams were left-hand engines.

Some of the Short 184s which had the 260 h.p. Sunbeam had a greatly improved engine installation. A flat frontal radiator was fitted immediately behind the propeller and the engine was completely enclosed. The pilot's forward view must have been greatly improved by this modification.

The ultimate production version of the short 184 had the Sunbeam Maori III engine. This power unit developed 275 h.p. but differed from the other Sunbeams in having its exhaust valves on the outboard sides of its cylinders. There was therefore no large central exhaust stack; instead there were two more slender stacks, one on each side of the engine. It appears that most of the machines with the Maori III retained the large elevated radiator.

The designations Intermediate 184 and Improved 184 were applied to some of the later versions of the design, but the precise definition of the variants in question has not come to light. It did not, apparently, relate to the type of engine which was fitted, for there are records of mixed batches of Short 184s: for example, the Sage-built batch N.1130-N.1139 were all originally fitted with the 240 h.p. Renault engine; yet N.1130-N.1134 were described as Improved 184s, the remainder as Original 184s. No doubt the designations indicated certain modifications to structure or equipment.

From early 1915 until the Armistice and beyond, the Short 184 gave good service in many theatres of war. On occasions they were used as night bombers to aid the R.N.A.S. Fifth Wing's campaign of late 1916. Five 225 h.p. Short 184s went to Mesopotamia in February 1916 where, operating from the Tigris at Ora under the command of the G.O.C. Mesopotamia, they helped to drop supplies on the besieged town of Kut-al-Imara.

Considerable numbers served in the Mediterranean, apart from those of the East Indies and Egypt Seaplane Squadron. In January 1917, the seaplane base at Otranto was originally equipped with six 225 h.p. Shorts transferred from Dundee air station; and in the following month it was decided to establish a torpedo seaplane school at Malta with four 240 h.p. Shorts as part of its equipment. By February 1918 the agreed establishment for Malta was twelve 260 h.p. Shorts.

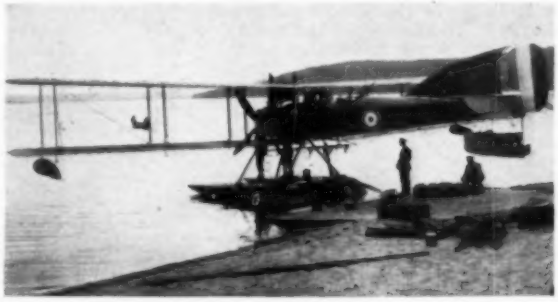
After the Armistice the Short 184 continued in service for a few years. A number went to North Russia in 1919 and participated in the campaign against the Bolsheviks; and in home waters the Shorts were flown on mine-spotting patrols. Other countries, such as Esthonia, Greece and Japan, had some Short 184s in the post-war years, and a few came on to the British Civil Register.

Short 184 with 260 h.p. Sunbeam engine and frontal radiator.

A landplane bomber conversion of the Short 184 was produced in 1916 and was flown by the R.N.A.S. Fifth Wing at Coudekerque and the Third Wing at Luxeuil. The bomber had both the 225 h.p. Sunbeam and the 250 h.p. Rolls-Royce engines, and was built in small numbers by several contractors. As a landplane, however, it is inappropriate to this history; it was soon withdrawn when the Handley Page O/100 became available, and was outlived by its seaplane progenitor.

The design which followed the Short 184 and its bomber development is one of the least-known Short seaplanes of the war, possibly because it has always—and erroneously—been confused with the Short 830. In point of fact, all that the two aircraft had in common was the 135 h.p. Salmson engine, for the 1916 type had a longer fuselage of improved design, a larger fin, and wings of greater span with double-acting ailerons on the upper mainplanes. The wings could, as usual, be folded, and the centre section had a large circular aperture, presumably to enable the observer to reach the retrieving sling easily and to fold the wings. The only visible indication of armament on the aircraft was the bomb rack under the fuselage, but it is possible that a machine-gun could have been mounted at some point on the aperture in the centre section.

Structure of the 1916 Short-Salmson seaplane was conventional, the wire-braced wooden airframe being fabric-covered with the exception of the decking about the cockpits, which was of plywood. The floats were wooden pontoons, and the tail-float had



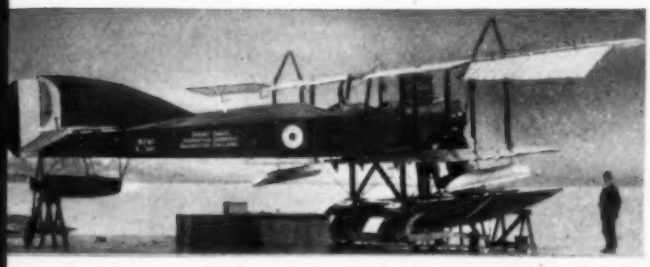
Short 184 with Sunbeam Maori III engine.

a water rudder. In appearance the new Short was much more handsome than any of its predecessors: it was better-proportioned and more nearly merited the description of graceful than any of its earlier, bedraggled-looking sisters. It was not produced in quantity, however: only ten (9781-9790) were built, and no record of their operational use has survived, though it is known that at least one was used at Calshot. Doubtless it was underpowered—the fitting of bomb racks indicated an excess of optimism—and was abandoned because the Short 184 and 827/830 designs fulfilled the Service needs of the time.

Contemporary with the 1916 Salmson-powered machine were two big seaplanes powered by the 310 h.p. Sunbeam Cossack engine. Apparently four prototypes were ordered at the same time, but it is doubtful whether more than one example of each was actually built. The two aircraft were quite different in appearance and in their designed function, but only the first type went into production. By the time that the production machines were forthcoming, the Cossack engine had been developed to give more power and was nominally of 320 h.p.

It has already been noted that the Admiralty favoured numerical designations for their aircraft, but in all earlier cases the number had been the serial number of a typical machine of each type. A unique departure was made in the case of the 320 h.p. Short seaplane, however, for its designation consisted of the numerical value of the horse-power of its engine, and it was known as the Short 320. There are, however, several references to the aircraft as the Short 310.

The Short 320 was designed to meet an official requirement for a seaplane capable of carrying a Mark IX torpedo, an 18-inch missile which contained 170 lb of T.N.T. and weighed 1,000 lb. It was considerably larger than the Short 184, but was unmistakably of Short design, particularly in such design details as the engine installation, the outline of the fuselage, the floats, and the typical tail assembly. The upper wings had long extensions and were fitted with inversely-tapered double-acting ailerons. The mainplanes could be folded.



Short seaplane (135 h.p. Salmson), 1916.

The torpedo was carried at a level midway between the bottom of the fuselage and the floats, and the float structure was so designed that the rear cross-bar could be removed to let the torpedo fall freely. On the production Short 320s there were additional vee struts which ran from the floats to the lower wings.

The Short 320 was flown from the rear cockpit, an arrangement which made the provision of effective defensive armament a matter of some difficulty. The ingenuity of the designer rose to the occasion—and so, perforce, did the Short 320's hapless observer when he had to use his gun, for the gun ring was mounted on struts which placed it level with the upper wing and he had to stand with his feet on the coaming of his cockpit. No doubt the fin and rudder were large enough to cope with the disruptive effect his body must have had on the slipstream. When the Short 320 was flown with a torpedo it was unable to lift an observer at the same time.

Production of the Short 320 was on a modest scale, and only one other contractor (the Sunbeam Motor Car Co.) undertook its manufacture. Production aircraft became available in 1917.

A long-range reconnaissance version of the Short 320 was also produced. As an alternative to the torpedo, it was fitted with extra tankage and bomb racks, and was used in small numbers as an anti-submarine patrol aircraft from home stations and in the Mediterranean.

Early in 1917, Commodore Murray Sueter was sent to Italy to command R.N.A.S. units there, with a particular view to making torpedo attacks on the Austrian fleet at Pola. He had suggested such an attack, together with a similar one on the German fleet at Wilhelmshaven, in a paper which he had submitted to the Board of Admiralty in December 1916. When Commodore Sueter was posted, an order for 25 Short 320s was placed; in February 1917 the establishment of the R.N.A.S. base at Otranto was to include 12, and two were to be sent to the torpedo school at Malta. The aircraft reached Italy before the end of April 1917, and the R.N.A.S. units were re-organized and renamed No. 6 Wing under the command of Wing Commander C. H. K. Edmonds—the same Edmonds who had scored two of the Short 184's torpedo successes in 1915.

Trials with torpedoes must have been made, for it is recorded in A.P.1344:—

"Towards the middle of 1917, two cases of failure of the 310 Short seaplane occurred in the Mediterranean. One of these occurred after releasing the torpedo, and when the pilot had climbed to a height of about 1,000 feet the fuselage collapsed, and the pilot was killed. At the time, this was considered to be due to the blow caused by the splash of torpedo entry, on the under surface of the fuselage. It was, however, eventually discovered to be due to an unsatisfactory method of securing the fuselage bracing wires. The result of these accidents was most unfortunate, and discouraged the development of our torpedo aircraft. Training was, however, continued at Malta with two machines, 310 Short, under Lieut.-Commander Hardy."

These accidents may have been the reason why the first attempt to use the Short 320s operationally with torpedoes was not made until September 2, 1917. Six machines—five carrying torpedoes, the other, bombs—were towed on rafts by motor launches to a point some fifty miles south of Traste Bay. Their intention was to torpedo enemy submarines lying off Cattaro, and their towed voyage was made because the load of petrol necessary for the machines to fly out and back from their base would have made it impossible for them to take off.

But when the Shorts were in position, the wind rose to gale force and heavy seas were running. Two pilots attempted to take off but were unsuccessful. The operation was abandoned; on the journey back to Otranto one of the Shorts sank and the others were damaged. Undaunted by this setback, Commodore Sueter asked for more torpedo or bombing seaplanes, and followed that request with a memorandum dated September 20, 1917, in which he pressed for a more vigorous offensive against Austrian ports. The Admiralty agreed to increase the total establishment of Otranto and Taranto to 80 seaplanes and landplanes, but it is doubtful whether that total was ever attained.

What is certain is that the Short 320 never launched a torpedo in anger. Two were sent from Otranto in *Manxman* specially to attack the German cruiser *Goeben* while it lay helpless after running aground south of Nagara, but they arrived too late, for *Goeben* freed herself and escaped before weather conditions were suitable for the Shorts to attempt to take off.

Because the attempts to use torpedo aircraft operationally had proved abortive, there was little practical experience of the behaviour of torpedoes dropped from aircraft. In February, 1918, therefore, four Short 320s were allocated to Calshot for torpedo experiments. Forty drops were made; three torpedoes were lost, two of them because the release gear functioned prematurely; and the results provided some useful information on the behaviour of torpedoes entering the water after being dropped from various heights and at various speeds.

Until the Armistice the Short 320 served as a reconnaissance seaplane. One example of the type was in service with the Imperial Japanese Navy; it may have been N.1485, which was sent there in 1918.

The second type of Short seaplane to have the 310 h.p. Sunbeam Cossack was a big equal-span machine which resembled the Short 184 closely. It was, however, a completely new aircraft. Its upper wing was of constant chord (that of the 184 had slight inverse taper), its centre section was an open structure, the rear float attachment was made by a strong vee strut (the Short 184 had two separate struts attached to either side of each float), and the engine cowling was much bulkier than that of the 184.

The equal-span 310 h.p. Short was known as the Short 310 h.p. seaplane, Type B: the significance of the Type B suffix is not known, though it seems reasonable to think that it might have been intended to distinguish the aircraft from the Short 320. To its makers at least, the aircraft was also known as the North Sea Scout.

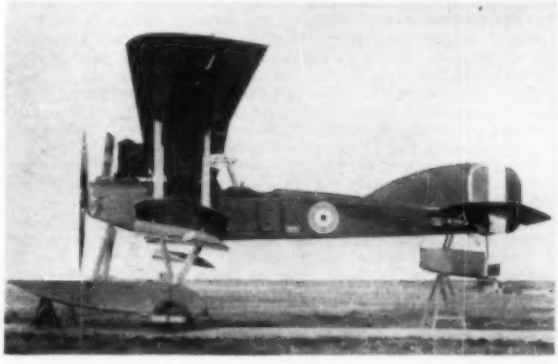
It may have been intended as an anti-Zeppelin aircraft, for its principal weapon was a 5-pounder Davis gun which could be fired upwards at an acute angle. For its own defence the aircraft had a Lewis gun. If the Davis gun were movable, the big Short had undoubted potentialities as an anti-submarine weapon, but the Davis gun was officially abandoned. So too, apparently, was the North Sea Scout.

The second batch of Short 320s ordered from Short Brothers were numbered N.1300-N.1319 and had the works numbers S.344-S.363. In the works numbers sequence they were followed by a seaplane which was completely different from any of its predecessors. The Short S.364 was a small, compact two-seater of remarkably clean appearance, powered by a 200 h.p. Sunbeam engine. A flat frontal radiator was fitted immediately behind the propeller, and a single central exhaust stack led the gases up over the centre section. The two-bay wings were of equal span and had elliptical tips; what was even more unusual about them was their rigid straight trailing edges, for all earlier Short seaplanes (except one variant of the 830) had wire trailing edges which produced the scalloped effect so characteristic of the firm's aircraft. The wings had a large gap and could be folded.

The neat fuselage terminated in a tail unit which was much smaller than any previously seen on a war-time Short seaplane. The small triangular fin was reminiscent of that of the pre-war Short 74, and its outline was followed in the shape of the balanced rudder. The pilot sat directly under the centre section, and an appreciable distance separated his cockpit from the observer's, which was surmounted by a Scarff ring-mounting. Twin pontoon floats, a wooden tail float with water rudder, and underwing air canisters were fitted.

According to Short records the S.364 was tested in March 1917, but singularly little information about the machine has survived. Apparently it was known as the Short Scout, but no official designation has survived; it is possible that it may have had the serial number N.36, but even that is uncertain. However it was styled,

Short 320.



THE SHORT SEAPLANE . . .

the Short S.364 was not adopted; apparently it was felt that all Service needs were still satisfactorily met by the Short 184.

Some influence of the S.364 was to be seen in the last Short seaplane of the war period, the N.2B, which appeared as early as December 1917. This time the designation was taken from the number of the Admiralty category to which it belonged.

The Short N.2B had two-bay wings with strut-braced extensions on the upper mainplanes. The wings could be folded, and they reverted to having wire trailing edges. The aircraft was powered by the 275 h.p. Sunbeam Maori, installed within a cowling which was liberally provided with louvres. There was a frontal radiator, but an alternative arrangement was contemplated in which the radiator was let into the leading edge of the centre section as a vertical surface. As on the S.364, the pilot sat under the centre section, and the observer was several feet farther aft. The tail unit, although smaller than that of the Short 184 and 320, yet retained a curved leading edge; the rudder was very similar to that of the S.364.

Official serial numbers were allotted for eight Short N.2Bs, but it appears that only two were built. The first, N.66, had floats of unusual form; each had a single step, a sharply tapering afterbody, and concave undersides. The second machine, N.67, had conventional, flat-bottom pontoon-type floats and slightly shorter ailerons; its radiator was of a different shape, and its exhaust stack was mounted obliquely. Both machines had large, wooden-covered built-up underwing floats, whereas all earlier Shorts had had fabric-covered air canisters.

Short S.364.

Short N.2B (second machine).

In terms of level speed the Short N.2B could show little significant improvement over the Short 184, but its climb and ceiling were considerably better. Possibly these aspects of performance were not considered to be of sufficient importance in a patrol seaplane to justify interference with the production of the Short 184, for the N.2B did not go into production. Shorts were engaged on the manufacture of F.5 flying boats and on the development of the Shirl, a landplane torpedo-carrier powered by a 350 h.p. Rolls-Royce Eagle VIII.

When the Armistice came, about 370 Short seaplanes of three types were in service with the R.A.F. The majority of them were Short 184s, and that type should always be remembered as one of the great aerial workers of the war; one which did much good, though unspectacular, work over many seas. The pity was that its designer did not live to see the final fulfilment of its duties: Horace Short had died on April 6, 1917. Of him, Maj. C. C. Turner wrote in his book, *The Old Flying Days*:—

"But Horace Short was the inspiring genius. Not only his development of the seaplane, and other types, but the sense of responsibility he had towards pilots, and the exacting care he took in aeroplane construction, helped to ensure the freedom of Eastchurch from fatal accidents in those days. He certainly laid the foundations of the British seaplane industry."

The final instalment of this history will consist of data on the Short seaplanes (performance, manufacture, serial numbers, etc.), together with a general-arrangement drawing.

FRED SIGRIST—AN APPRECIATION

IN an appreciation of Mr. Frederick Sigrist, who died on December 10 [and an obituary notice of whom appeared in *Flight* for December 21], Sir Thomas Sopwith, chairman of the Hawker Siddeley Group, writes:—

"Fred Sigrist was one of the pioneers of aviation. Although his name does not appear in any Royal Aero Club list of record-holders he was one of the best engineers I have ever known and because of this aviation owes a great debt to his memory. He had the priceless gift of getting the best out of all who worked with or under him, partly because he knew his job but principally, I am sure, because he was so completely genuine.

"Fred Sigrist was a Jerseyman. I first met him when he joined the crew of an auxiliary schooner as engineer in 1909. Within a year we were immersed in the early days of flying and in December 1910, largely owing to his genius in persuading our early engines to keep running, we were able to fly from Eastchurch to Belgium.

"In 1911 we started the construction of aircraft, first in a shed at Brooklands and then in a disused skating rink at Kingston. Fred Sigrist was largely responsible for the construction of the early types of biplane, one of which, the Tabloid, won the Schneider Trophy in 1914; and from them grew the line of aircraft which played such an important part in the 1914-18 war . . ."

After recounting the story (which he told at the recent Sopwith Apprentices' Dinner) of how the Tabloid floatplane was practically rebuilt in three days before the 1914 Schneider Trophy contest, Sir Thomas continues:—

"Like many other companies, we suffered the usual post-war setbacks; but eventually the H. G. Hawker Engineering Co., Ltd., was formed, and Fred Sigrist became a director. He stayed on the Board through various changes and when, in 1935, we formed the Hawker Siddeley Aircraft Co., Ltd., he became one of its first two joint managing directors. Before World War II he was beginning to show signs of being unable physically to stand up to our winters, and on medical advice he retired to build a house in Nassau. I am sure he would not have survived so many years but for the fact that the climate there suited him so perfectly.

"Fred Sigrist was one of the most cosmopolitan of men. He went all over the world showing the Hawker flag and evidence of his world-wide interests is that on his death he was a member of clubs in London, Paris and New York. I last saw him six weeks ago when he was over in this country. He still suffered every now and then from heart attacks and he was very ill when he was over here. The best clue to his character that I can think of is that in the 46 years I knew him we never once had a cross word or disagreement—even when we were engaged in the temperamental business of designing and building aeroplanes. He was a great character and many of the early officers of the Royal Flying Corps and the Royal Naval Air Service will share with me the loss of a very dear friend."

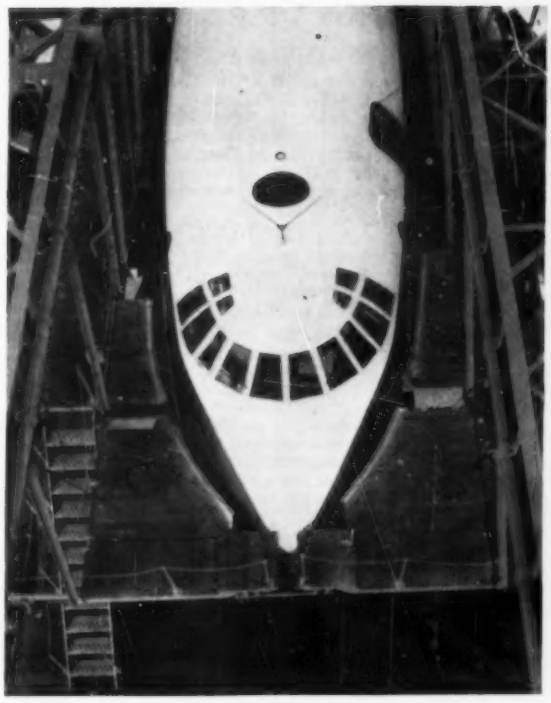
TALKING ABOUT ROCKETS

(Continued from page 998)

used could not have been much below 1,500 lb and the rockets themselves could have been a modified form of V2.

Professor Pokorowski, Director of the Institute of Experimental Aeronautical Medicine in the Academy of Sciences, described the release of dogs, after suitable familiarization training, from rockets at an altitude of nearly 100 km, at first in hermetically sealed containers with their own oxygen equipment and then exposed to the atmosphere but fitted with removable headgear and an oxygen supply. In both instances the dogs parachuted to earth safely and wagged their tails on landing, "like any record breakers." Despite a duration of flight of over two hours, a speed of 1,000-1,150 m/sec during a portion of the descent (at an altitude of 35-50 km in one instance), and exposure of one hour in the upper layers of the atmosphere, no ill effects were observed in the animals by the instruments installed during the flight or afterwards. All their organs functioned normally and respiration, pulse and temperature variations were in most cases slight. It may therefore be said that man may himself safely fly, for short periods, at such altitudes and conduct further atmospheric research, when suitable vehicles become available.

Both Soviet speakers made appeals for co-operation and the exchange of information on the subject of their studies; and on this note of hope the Congress closed.



Britannia Dock: Maintenance of B.O.A.C.'s Britannia fleet will be facilitated by this close-fitting platform into which the aircraft is towed backwards through hinged sections. Electric, compressed air, hydraulic and water points eliminate pipes across the hangar floor.

CIVIL AVIATION

GROWTH OF B.E.A.'s AIR FREIGHT

CARRIAGE of freight by air to offset seasonal traffic declines can rarely provide profitable load factors. It is the regular availability of capacity in all-freight aircraft or passenger transport holds that will encourage a greater expansion of air freight. On a world basis, passenger traffic has increased by an average of about 17 per cent each year since 1950; cargo traffic has gained ground by only about two-thirds of this amount.

But this expansion may not be so very distant. We have recently had occasion to record spectacular increases in the freight carried by the British independents Silver City—on their specialized "Roadair" service—and by Hunting-Clan's Africargo flights. It is heartening to learn that B.E.A. have also experienced a major expansion in their air freight business—25.8 per cent more in the past twelve months. This represents a 24.9 per cent increase in the cargo tonnage carried; and the revenue earned—estimated on current trends to amount to "well over" £1,500,000 by the end of the financial year—should have increased by £500,000 in the past two years. This would mean that for the first time the Corporation's freight income will exceed that earned from the carriage of mail: a service which brought in £1,554,241 last year (freight revenue was £1,290,669). The Corporation's slice of the air cargo business—an average of sixty short tons a day is carried by B.E.A.—is now nearly three times greater than that of its nearest European competitor.

Typical of air freight is the wide variety of goods carried—radio sets and gramophone records, bolts of cloth, machinery and furs form some of the Corporation's regular mass consignments. To attract more business specialized containers have been developed: a new cardboard crate enables clothing to be densely packed without creasing and special equipment has been developed for the bulk carriage of livestock. At the other end of the scale the airline's Pioneer-Leopard double-door freighters (special DC-3 conversions) have also carried machine-tool units which weigh up to two-and-a-quarter tons.

Yet in spite of the DC-3's capacity for high-density loads—and a significant part of B.E.A.'s freight traffic increase is reported to stem from this capability—over 60 per cent of all the Corporation's freight traffic is still carried in the holds of scheduled passenger aircraft. It was for this application that the Viscount 701 was designed with large hatches and a commodious freight capacity. The Viscount 802, due to enter service with the Corporation early next year, has even greater underfloor space. B.E.A. are also well ahead with plans for an express all-freight version of the Viscount.

The conclusions of *Flight's* survey of traffic and transports in 1962, "The Hungry Airlines" (November 23 and December 14), pointed to the Vanguard as a near-optimum aircraft for a large share of the airline's business in the 1960s. An all-cargo version (*Flight*, October 5), with the tremendous freight capacity of 40,000 lb, has also been studied by the manufacturers. If the upsurge of British air-freight business continues at the level of the past twelve months it will be reassuring to know that the right aircraft will be available.

NORTH ATLANTIC AID

THE provision of all the essential navigational services and airfield facilities that are required (under the terms of the Chicago convention on International Civil Aviation) by North Atlantic traffic in Greenland, the Faroe Islands and Iceland would represent a heavy financial burden to these countries if no outside assistance were forthcoming. Even eight years ago the bill for air navigation facilities in Iceland came to £214,000 a year. But in certain instances (as we explained in our issue of September 21), the International Civil Aviation Organization will take alleviating "joint support" action to provide financial and technical aid.

The Danish and Icelandic facilities—the cost and the manning of which would be disproportionate to the benefits that these countries obtain from their own installations—fall into this category. The financing of these services was reconsidered this year by a Joint Support Conference which first met in Geneva in September, and a new agreement on the way in which money for certain air navigational facilities should be provided has recently been approved. The agreement, which will be implemented on January 1, 1957, was signed by the representatives of 14 participating nations—Belgium, Canada, Denmark, France, Germany, Iceland, Israel, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom and the United States. It supersedes a previous arrangement made in September 1949 between the I.C.A.O. council and Denmark, and an agreement between the council and Iceland made in September 1948. It will provide for manned air traffic control, meteorological services, a telecommunications network and radio navigation aids in Greenland, the Faroes and Iceland for all transatlantic air carriers.

The joint support that the fourteen nations will provide amounts to 95 per cent of the actual cost of the services—except that in one calendar year this must not exceed £385,000 for the Icelandic facilities or £440,000 for those provided by Denmark. The proportion that each government will contribute is decided on a "fair shares" basis determined by the amount of "aeronautical benefit"—the number of complete Atlantic crossings flown by their civil aircraft in each calendar year—that each country will receive.

The new agreement was thrashed-out at Geneva between the interested states while the I.C.A.O. council acted in an administrative capacity with "specifically defined responsibilities." This represented a departure from the previous practice whereby bilateral agreements were made between the council and the governments of Denmark and Iceland, and it was agreed to be a success.

Members of the Fédération International des Transports Aériens Privés visited Radlett on December 11 to inspect the Herald. Among the visitors, who were met by Sir Frederick Handley Page, were F.I.T.A.P.'s president, A. Cdre. G. J. Powell, and secretary, M. Riche.

CIVIL AVIATION . . .

THANKS FOR THE AIRLIFT

UNSTINTED aid was given by the independents and the Corporations to the British Red Cross Society in their work of Hungarian relief (see *Flight*, December 21). An appreciation of their contribution has been sent by Lord Woolton, chairman of the Society, to B.O.A.C., Eagle Aviation, Dan-Air Services, Air Kruise (Silver City), Skyways, Derby Aviation, B.K.S., Starways, Cambrian Airways and Transair in a telegram which reads:—

"The British Red Cross Society wishes to express its most sincere thanks to all the pilots and aircrews, the ground crews and others behind the scenes who have laboured so hard and long during the Hungarian airlift. Their continued efforts have resulted in over 7,000 Hungarian refugees travelling to this country speedily and in comfort."

ELECTRA ASSEMBLY BEGINS

WITH the scheduled date for the first flight now only a year away, Lockheed's Electra programme is in full swing. Initial assembly operations on the 42ft milled wing-skins, the wing spars and trailing edges—following the intensive stockpiling of Lockheed-fabricated and bought-out parts—are expected to begin early in the New Year. The build-up of the main wing box-spar will start in February and will then be followed by assembly of the fuselage structure. Lockheed intend to start final assembly-line operations in August and to deliver the first aircraft to the Burbank engineering flight test department in December. The flight-test programme for the first eight months of 1958 will involve "intensive" flying with six aircraft.

While manufacture of the airframe gets under way, Lockheed are hoping to establish a "head start" of 800,000 Allison 501 D-13 engine hours before the first Electra is delivered. A Constellation (the "Old 1961") had accumulated 207 hours' flying with a T56 military engine modified to resemble the civil D-13 when the test programme was completed. A genuine D-13 is now being fitted, and should be flying in the same airframe in February.

A more ambitious project is the complete re-engining of a Super Constellation test-bed with these engines and with Aeroproducts 606 propellers. The laboratory airframe will also incorporate "major Electra systems," and it should fly in July. The Constellation will be used to accumulate as many engine hours as possible—Lockheed's goal is 1,000—under all climatic conditions and at altitudes up to 30,000ft.

An innovation on the Electra—still tentative at the time of our July 6 "Airliners of the World" issue—is the use of four preloaded baggage containers and hoists to expedite ground handling. The "tubs" will be graded according to destination, and are arranged to slide into the lower fuselage or rollers, filing-cabinet fashion. It is claimed that all four can be removed and replaced in four minutes.

The Aircraft Owners and Pilots Association is encouraging the owners of all U.S. civil aircraft—private and commercial—to display this shield as "a deterrent to intending saboteurs."

WARNING
BY AN ENACTED FEDERAL LAW, WHOEVER WILFULLY DISABLES OR INCAPACITATES THIS AIRCRAFT OR PARTS THEREOF IS SUBJECT TO FEDERAL PROSECUTION AND PENALTIES RANGING FROM A MAXIMUM FINE OF $10,000 AND 20 YEARS IMPRISONMENT TO THE DEATH SENTENCE, SHOULD DEATH RESULT. THE AIRCRAFT OWNERS AND PILOTS ASSOCIATION WILL ASSIST THE OWNER OF THIS AIRCRAFT AND ALL LAW ENFORCEMENT AGENCIES IN APPROPRIATE APPREHENSION AND PROSECUTION ACTIVITIES.
SERVICE
AIRCRAFT OWNERS AND PILOTS ASSOCIATION

BREVITIES

Dragon Airways are to suspend services from Newcastle-upon-Tyne airport from January 5.

* * *

Swissair has received its second DC-7C. The aircraft carried a ton of clothing for Hungarian refugees from California.

* * *

A joint sales and operation agreement has been filed for approval for the C.A.B. by the Flying Tiger Line and T.W.A.

* * *

The Ceylon Ministry of Transport is planning a network of internal air services as part of the civil aviation expansion scheme for the island.

* * *

I.A.T.A. have appointed an international turbine operations panel to co-ordinate the airlines' efforts in developing efficient flight procedures.

* * *

A Dictaphone service is available for first-class passengers flying in B.O.A.C. Stratocruisers between London, New York and Montreal.

* * *

During one week of the Olympic Games period five of T.A.A.'s Viscounts averaged 11.58 hr per day. The remaining four aircraft averaged 9.64 hr per day.

* * *

Recent reports that London Airport runway extensions are to cost £3m have been emphatically denied by the Ministry of Civil Aviation; the Minister has stated in Parliament that reliable information on ground requirements is being awaited from the airlines before any decision is made.

THE NEW AIRWAYS SYSTEM

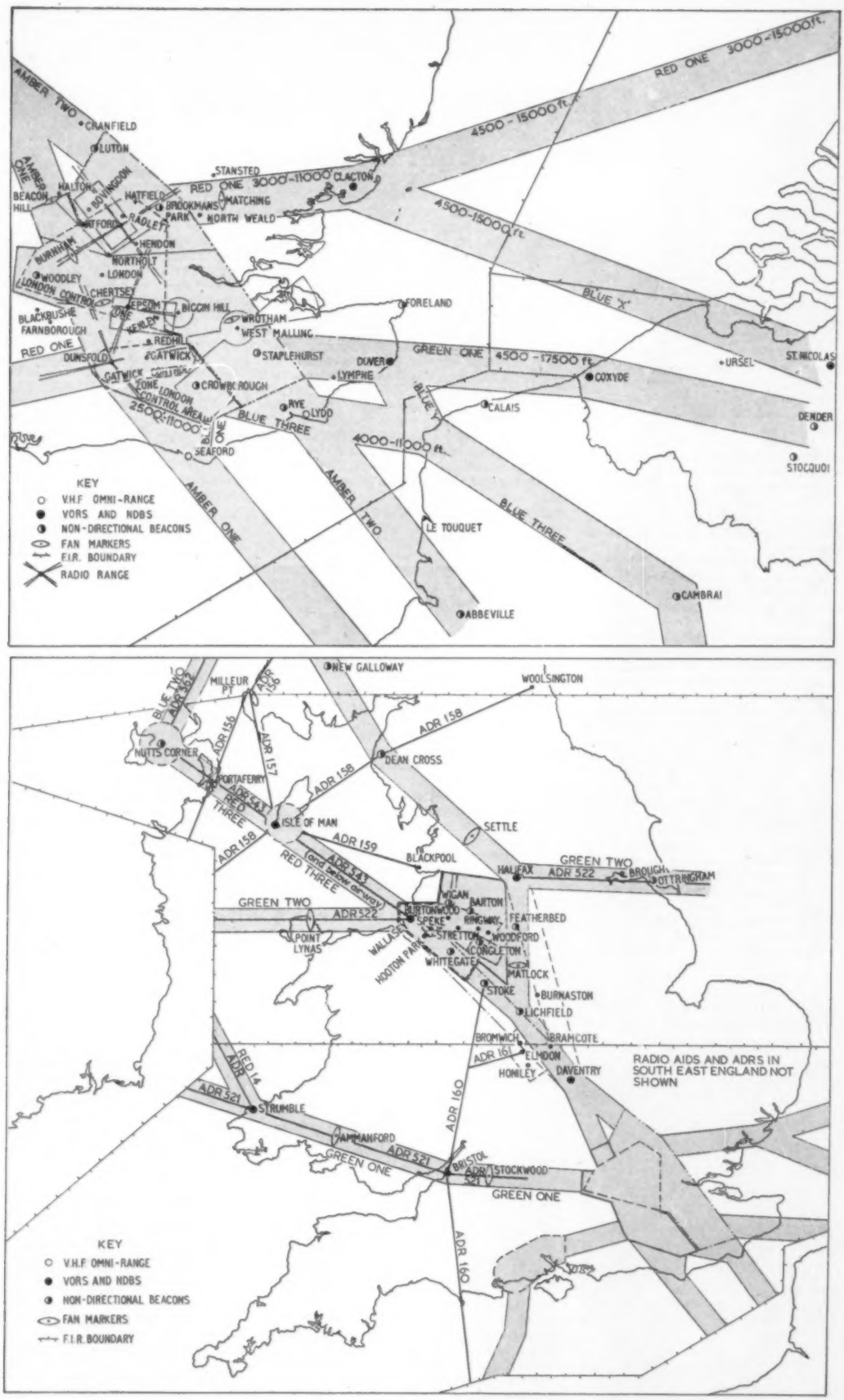
NO system of control can work efficiently when it is in danger of becoming swamped. This is particularly true of the regulation of air traffic, where congestion—resulting in early stacking and long delays when visibility margins fall—is anathema to pilot, passenger and controller alike. The rapid growth of civil air traffic over these islands has made inadequate much of the present airways system (which was first introduced in 1950), particularly over terminal areas where the air corridors converge. Additional difficulties presented by the changing pattern of military aviation—higher operating speeds and altitudes, intensified night and all-weather flying and the freedom of action that Service aircraft demand—have also pointed to the urgent necessity of revising the existing airways system.

On December 14 (as announced in *Flight* of December 7) the Ministry of Transport and Civil Aviation presented its plan for the much-needed changes. The new airways system (maps of which appear opposite) was discussed with organizations representing the pilots, the operators and the manufacturers. Not every voice was raised in assent—the British Gliding Association have already had something to say about the airway which is to pass over Great Hucklow—and the Ministry of Supply and the Royal Aero Club were on hand to contest any encroachment upon the relative freedom of the airfields of manufacturers and private pilots. But most criticism of the plan was concerned with its details: an appeal for the base of Blue Three airway to be raised to give private pilots a greater altitude for crossing the channel and slight boundary modifications to enable Red Three airway to be skirted without flying too far out to sea—suggestions that were sympathetically received by the Ministry.

The changes in the South-East England area have been made to simplify the task of individual controllers at the Southern Air Traffic control and to expedite the handling of the increasing traffic between Britain and the Continent. Comparison with the now-dated system shows that the most obvious revision has been to create new airways to Belgium (Blue X) and to Holland (Red One) passing over the Clacton area. Two more new airways lie between Cap Gris Nez and this country (Blue 3 and Blue Y), and the one to Belgium *via* Dover has been realigned. These easterly extensions from the London Control Zone will eventually replace the easterly legs of Red One and Green One on the old airways map. The airway to Belgium and Holland should be in operation in April 1957, and airways Blue 3 and Blue Y should both be in full service by the end of that year. By spring 1958—with a control zone and associated airways radiating from Gatwick Airport—the whole new system should be complete.

The problem facing the M.T.C.A. in central England was to increase the capacity of the Manchester control zone and to permit overflying traffic to by-pass the low-level traffic. This has been tackled by splitting Amber One—the central "backbone" of the present system—into a Prestwick leg and a Belfast leg from either Lichfield or Daventry. Two proposals are shown on the map; the dotted lines indicate the more tentative routes. The Central England plan will be introduced in stages after the South-Eastern airways scheme is in operation: some minor changes, taking account of particular local problems, are likely to be made before the plan is put into effect in 1960, when wider surveillance-radar coverage will also be available. Scottish systems will also come under review in the near future.

The next step is to implement plans for controlling the air space not only above the present level of 11,000ft—a new upper limit to the height of the airways is expected to be brought into operation in 1957—but when it is inhabited by the big jets. This problem is now being discussed with the NATO committee on European Airspace Co-ordination, and next year it will come under the province of I.C.A.O.'s Europe-Mediterranean Regional Air Navigation Meeting.



Revised airways systems for Central England and (top) the South-East area. The modifications are summarized opposite.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

The McKenna Dinner

SURELY the foremost test pilots' gathering in Britain is the annual McKenna Dinner with which the Empire Test Pilots' School celebrates the conclusion of each test pilots' course.

At this year's dinner, for No. 15 Course, the guests included Air Marshal Sir Claude Pelly, Controller of Aircraft, M.o.S.; Admiral W. T. Couchman, Deputy Controller; A.V-M. H. D. McGregor, Assistant Controller; Mr. E. T. Jones, Director-General, Technical Development (Air), M.o.S.; A. Cdre. R. A. Ramsey Rae, Commandant of A. and A.E.E.; Mr. D. E. Morris, Chief Superintendent A. and A.E.E.; Mr. G. W. H. Gardner, Director of the R.A.E.; G/C. D. C. McKinley, Superintendent of Experimental Flying at R.A.E.; Cdr. K. R. Hickson, Commander Flying at R.A.E.; and G/C. W. K. Stewart, O.C. Institute of Aviation Medicine.

Many of the chief test pilots from the British aircraft constructors were present and the "allied and friendly nations" were represented by A. Cdre. N. Ford, R.A.A.F. H.Q., London; Lt-Cdr. J. P. Whitby, Canadian Joint Staff London; Brig-Gen. A. Puget, French air attaché in London; and Lt-Cdr. Mauban, Commandant of the French test pilots' school at Brétigny.

After dinner, G/C. S. Wroath, Commandant of E.T.P.S., rose and "called for the titfer." Then, placing this traditional mortar-board on his head he made his report of E.T.P.S. progress during the past year. He welcomed the guests and went on to wish good luck to Bristol's chief test pilot, "Bill" Pegg, who is retiring from test flying.

The E.T.P.S. year, the Commandant said, had been one of consolidation with no exciting developments. A new flying building had been completed early in the year and the ground school was considerably improved. By subtle means the School had set up a finely executed and most generously proportioned notice-board facing the main road. E.T.P.S. was now responsible for 70 per cent of the use of Farnborough's runway and was the noisiest component now using the airfield.

Efforts had been made to get the best out of the school's fleet of aircraft, particularly by improving servicing facilities, and there was now a heated servicing hangar. While the fleet was now up to date, the emphasis was passing steadily to jet and turboprop aircraft, with emphasis on teaching high-speed flight techniques. There would soon be a need for experience of rocket-power. Flight-test instrumentation had been improved, though it was still the school's belief that test flying should be taught basically by the use of the older knee-pad methods.

After consulting his horoscope in a Sunday paper and finding it warned him not to air controversial views when authority was around, the Commandant said that the R.A.F. must take more interest in the provision of test pilots so that it could exert an influence on aircraft right at the beginning of their development. He noted that in the lists of McKenna Trophy winners there were few R.A.F. names. In conclusion, G/C. Wroath complimented both the E.T.P.S. instrument rating flight and the circuit and approach controllers at Farnborough on their excellent work; and thanked manufacturers for "the many interesting visits" which had been arranged for the School's students.

Finally, the Commandant added that during the course which was now ending three students had obtained distinguished passes; and, after the most careful consideration, the McKenna Trophy had been awarded jointly to Lt-Cdr. J. S. Humphreys, R.N., and Lt. J. A. Hablot, French Navy.

Air Marshal Sir Claude Pelly then rose to say that since he had held his new post for only a short time he had "nothing earth-shaking to say." He made it clear that test pilots, as opposed to black boxes, were still needed, and recalled Lord Trenchard's statement that, though individual pilots talked a great deal of nonsense, the opinions of pilots as a whole should be carefully noted.

Sir Claude then presented the McKenna Trophy to the two winners and each in their turn made a brief speech of thanks. Lt. Hablot said he had greatly enjoyed the course. He hoped that guided missiles would not soon replace piloted machines, firstly because it would mean no more fun in the air for the pilots, and secondly because the M.o.S. would have to find another posting for G/C. Wroath.

Air Marshal Sir John Whitley, Air Member for Personnel designate, steps from a Pembroke of No. 267 Sqn. at Kuala Lumpur during his tour of inspection of R.A.F. bases abroad. His pilot was A.V-M. W. H. Kyle, A.O.C. Malaya. Sir John had piloted himself from England in a Canberra B.6.

Christmas Island

A BASE for British nuclear tests next year is being rapidly prepared on Christmas Island, an atoll in the Pacific. The Army has already completed 25 miles of good roads, an auxiliary airstrip and a 7,000ft runway suitable for bombers. Thousands of tons of heavy equipment and stores have been brought in by sea; and mail and fresh foods are flown in from Honolulu by R.A.F. Hastings. A forward airstrip is to be built on Malden Island, about 400 miles to the south.

Personnel on Christmas Island subscribed through a toy manufacturer in England, to send a considerable quantity of toys to children in hospital in England over Christmas.

American Gift

ON behalf of the U.S.A.F., Maj. Gen. Roscoe Wilson, Commander 3rd U.S.A.F., has presented a cheque for £25,000 to Mr. Nigel Birch, the Air Minister. The money was contributed by American servicemen all over the world towards the reconstruction of the R.A.F. Church, St. Clement Danes, London.

Command Progression

THE post of A.O.C-in-C. Transport Command has been up-graded from air vice-marshal to air marshal.

A.V-M. F. R. W. Scherger, R.A.A.F., is to succeed Air Marshal Sir John McCauley as C.A.S. of the R.A.A.F. next March. Sir John is retiring.

A.V-M. R. Faville is to be A.O.C. No. 22 Group, Technical Training Command, with effect from January 15. He will be succeeded in his present post as Commandant of the R.A.F. Staff College, Bracknell, by A. Cdre. S. C. Elworthy who will receive the acting rank of air vice-marshal.

A. Cdre. D. A. Evans is to be S.A.S.O. Fighter Command, with the acting rank of air vice-marshal, with effect from January 1.

A. Cdre. A. F. Cook is to be Principal Medical Officer, M.E.A.F., in January, with the acting rank of air vice-marshal.

R.N.Z.A.F. Squadron Badge

BEFORE leaving Auckland, the Duke of Edinburgh presented a badge to No. 40 (Transport) Sqn., R.N.Z.A.F. It depicts a mariner's compass with the inscription (in Maori) "To the four winds."

Auxiliary Appointment

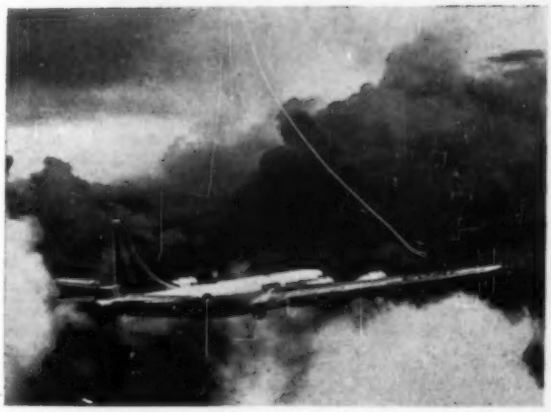
IT is announced that W/C. E. Swinney has been appointed to command No. 3631 (County of Essex) F.C.U., R.Aux.A.F., which is based at Chelmsford. W/C. Swinney retired from the R.A.F. in 1955 after over 30 years' service. He had most recently been Chief Signals Officer at Central Fighter Establishment, at Central Bomber Establishment and at No. 83 Group, 2nd T.A.F., before retiring.

Naval Promotion

THE Admiralty has announced the promotion of Rear Admiral A. R. Pedder to Vice-Admiral with effect from December 10. Admiral Pedder, at present serving in the Admiralty, entered the Navy in 1918, and is a naval aviator of considerable experience. At the beginning of World War 2 he was with the Naval Air Division at the Admiralty; and commanded the escort carrier *Khedive* in the Far East in 1945. He later served on the Maritime Air Committee and between 1954 and 1956 was Flag Officer, Aircraft Carriers, the squadron consisting of *Eagle, Ark Royal, Centaur* and *Albion.*

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns; the names and addresses of the writers, not for publication in detail, must in all cases accompany letters.



The photograph of a WB-29A-BN in dirty weather, referred to in the letter below from Mr. Charles W. Cain.

U-2 Reflections

UNWITTINGLY, *Flight's* news paragraph on the Garboesque Lockheed U-2 "St. Peter's Special" (December 14, page 916) has, most aptly, renamed a little-publicized but highly utilitarian facility of the U.S. Military Air Transport Service.

With something like 50,000 operational hours of Air Weather reconnaissance logged during 1956, the A.W.S./M.A.T.S. might properly be renamed *All*-Weather Service, as you suggest.

The accompanying photograph is—as that pre-Communist Chinese saw manufacturer observed—". . . worth a 1,000 words." It shows an A.W.S./M.A.T.S. Boeing WB-29A-BN Superfortress approaching some particularly nasty weather.

Each flight may last up to ten hours. The older WB-29s are now being replaced by WB-50D and H Superfortresses—also fitted with the weather-observation "periscope" which may be seen on the rear fuselage of the accompanying WB-29A.

That there is much more to the operational potential of the Lockheed U-2 is indicated by the top security classification which the U.S. Pentagon has applied to this high-flying "snoopship." The fact that so many top-rating agencies are concerned with the U-2 is significant, and may account for the armed-guard protection afforded this civilian-flown "St. Peter's Special."

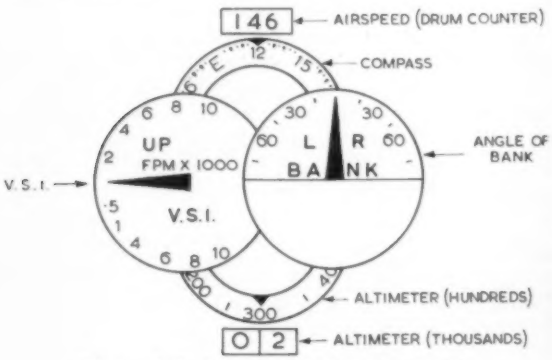
Now that *Flight* has "scooped" the U-2 revelation, I await publication in the rival (U.S.) aviation Press of full details of the highly-hush-hush Aberporth Oozoolum Bird BT(U) Mark I—Britain's first "Missile that Thinks," known to the natives as the "Inner Circle."

London, W.8. CHARLES W. CAIN.

High Performance

I READ with interest the article entitled "High-performance Instrumentation," in your issue of November 23. Mr. Morss has apparently given much thought to the plight of the idealistic instrument pilot, and most of his criticisms of present equipment are, indeed, justified. The blind-flying panel of today's jet fighter is for the most part obsolete and unimaginative. However, it is all very well to put forward what the intelligent pilot would consider an ideal instrument panel, but unfortunately the problems are numerous, and many of the instruments we would like, while theoretically sound, are very often structural pipe-dreams.

Mr. Morss' first innovation is an angle-of-attack indicator. The angle of attack of a wing is the angular difference between the effective chord line of the aerofoil and the oncoming airflow. No means of measuring this angle, in the manner suggested by your correspondent, is known to modern aerodynamicists. An angle of attack of say, 10 deg can be achieved at an infinite number of airspeeds, and in an infinite number of attitudes. The lowering of flaps alters the effective chord line of the wing. The operation of elevons on delta-winged aircraft does likewise. A very indirect and unreliable indication might be possible by making use of the changing pressure envelope over the top of the aerofoil as angle of attack is increased. (Static-vented capsules along, say, the point of maximum camber might measure decreasing pressure as the angle is increased.) But innaccuracy would render such an instrument useless. For example, how would it differentiate between changes in speed (V^2 *in* $C_L\frac{1}{2}\rho V^2 S$) and changes in attack angle (C_L), both producing changes in pressure?



"Firecan Jockey's" suggested blind flying panel.

The only other method would be to provide a radial comb of pitot tubes at five-degree angles up to about 20, so that when the wing was at 20 deg the airflow would be parallel to the lowest tube, thereby giving the greatest capsule expansion, and thus the highest reading of the four dials or counters. This would, again, be indirect, and could not of course be represented on the type of indicator Mr. Morss has in mind.

Secondly, he has discarded the airspeed (dynamic pressure) indicator, and replaced it by a ground speed meter (=T.A.S., assuming still air), remarking that the pilot is more interested in his speed through his environment than the airloads on his aircraft. I would say a pilot was not at all concerned about environmental speed, for what does it really tell him? It gives him navigational information, certainly, but this is far better done by radio or radar instruments, such as D.M.E. and radio compass, which will tell him at a glance his distance (and bearing) from a chosen reference point—presumably base.

Much better retain the conventional A.S.I. for approach and landing work, so that the pilot knows how much "bite" he has on the air at these critical stages. I doubt if an angle-of-attack indicator would be of much use with highly swept or delta-wing aircraft, since these are prone to what is known as "super stalling"—where, on the approach to land, the a/a is increased slightly to increase the lift, and the rate of sink is almost doubled for a comparatively small increase of a/a.

For the supersonic stratospheric period, a radar/electronic "speed over the earth's surface" instrument might be useful (the present day type of A.S.I. would be of little use for this purpose, for, to take an extreme example, a true speed of 2,000 kt at 200,000ft would barely show on it (about 6 kt).

The pitch indicator is a good idea, but, again, I cannot see what real use the instrument pilot would have for it. He is not really concerned about the angle his aircraft's longitudinal axis makes with the ground—what he is concerned about is the rate at which he is approaching the ground (in fact, this instrument would not work at all in a recent American light spotter aircraft, in which the control column moves the mainplanes, the fuselage remaining level). Personally, when flying on instruments, I never find any need for pitch information—the V.S.I. tells me all I want to know—whether I am going up or down, and at what rate.

Criticisms of the present V.S.I., incidentally, are more than justified, and this indicator, which in my opinion ranks as the master instrument in high-speed jet flying, could easily be improved to read climbs/descents of up to 10,000 ft/min, by the use of logarithmic scaling, or otherwise.

The capsule pressure altimeter as we know it, is well nigh useless in the high stratosphere (indeed, the best model today is good up to 50,000ft only). I do think this instrument, like many others, will almost certainly be replaced by an electronic device in the multi-Mach stratospheric aircraft of tomorrow.

The combination of many instruments on one dial face has been thought about for many years, but the physical obstacles are many and discouraging. Far better feed the information from all these into one dial—which is admirably done in the Zero Reader, where a vertical bar, which receives signals dealing with roll, yaw and direction, and a horizontal bar, receiving signals dealing with climb, dive and pitch, are made to cross in the centre of a circle when the aircraft is on "path."

Shown in the sketch is what I would consider a compact and *simple* (important!) blind-flying panel.

R.A.F. Horsham St. Faith. FIRECAN JOCKEY.

THE INDUSTRY

Sir George Godfrey Report

IT has been announced by Sir George Godfrey and Partners (Holdings), Ltd., that their profit for the year ended August 31, 1956, after deducting taxation and other expenses, was £237,406. This compares with £279,259 for the previous year. A dividend of 22½ per cent on the ordinary shares is proposed.

The company's full report and accounts are due to be issued today (December 28) and the annual general meeting is to be held on January 23.

Automatic Announcer

AN automatic announcing system has been developed by Southern Instruments, Ltd., Frimley Road, Camberley, Surrey. Called "Repetina," it records any spoken message or instruction and then repeats it—in several different languages if desired—over any number of loudspeakers. Repetina can be set to operate either once or continuously, at pre-determined intervals; it is completely mobile and is said to operate as well on vehicles as indoors.

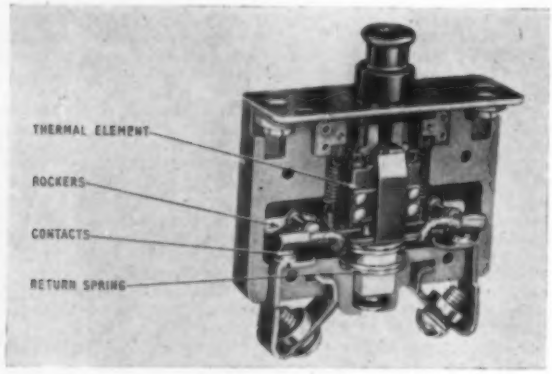
Steel Sheet Data

TO help the aircraft industry in familiarizing itself with the S500 series of British Standards for steel sheets and strips [see p. 159, *Flight*, July 27] the Society of British Aircraft Constructors has issued an addition to its range of materials data sheets. This new one, M.A.T.6 (Sheet and Strip), complements the recently revised M.A.T.1 covering specifications for steel bars and forgings. It provides a complete reference to the complete B.S. range for steel and strip, and also to those D.T.D. specifications still available for more specialized requirements. Copies of the schedules and of data sheets M.A.T.2-5 (covering aluminium alloys in the form of sheet, strip, castings, bars, forgings and extruded sections and tubes) are available from the S.B.A.C. at 29 King Street, St. James's, London, S.W.1, price 1s per copy or 6s for six sheets.

Electrical Overload Protection

IMPROVED protection against electrical overloads in aircraft is claimed as the virtue of a new circuit breaker now being manufactured by the Plessey Co., Ltd., Vicarage Lane, Ilford, Essex, under licence from Mechanical Products, Inc., of Jackson, Michigan, U.S.A.

This Type "A" breaker is designed to withstand overload currents up to 6,000 amp without suffering damage. Under excess load the thermal release will break the circuit independently of the mechanical switch latches, even if the operating button is held in the "on" position.



Details of the Plessey Type "A" circuit breaker.

A push-pull button switch has been adopted as the most positive method of control. Visual indication of setting is given by a white band round that portion of the button stem which is visible only in the "off" position; so it is possible to see at a glance when the thermal overload device has been tripped. Contact pressure is maintained by steel extension springs which carry no current, connection between the contacts and the thermal element being effected by means of flexible conductors.

Type "A" circuit breakers are available in current ratings from 5 to 50 amp and comply with British and American aircraft specifications. Full details are contained in Publication No. 868, from the Plessey aircraft and automotive group, Ilford.

A Vulcan nose radome, photographed in the Avro works. Moulded with Bakelite polyester resins reinforced by glass fibre, it is stated to combine high strength/weight ratio with good radar transparency.

IN BRIEF

The head office of the Mullard Organization is now at Mullard House, Torrington Place, London, W.C.1 (Telephone: Langham 6633).

* * *

Well known in the United States, Almco equipment for the barrel-finishing of small parts is now being sponsored in this country by Almco Supersheen Division of Great Britain, Ltd., Bury Mead Works, Hitchin, Herts. American users include Boeing, Solar, G.E.C., Bell, Vertol and Sikorsky.

* * *

We regret to record the death recently, at the age of 82, of Mr. W. S. Naylor, chairman of the Chloride Electrical Storage Co., Ltd., from 1929 until he relinquished the position in July 1946. Mr. Naylor joined the Chloride Co. in 1902 as assistant manager, became general manager four years later and in 1921 joined the Board of directors.

* * *

Mr. M. A. East has relinquished his post as head of the technical sales department at Western Manufacturing (Reading), Ltd., and joined S. Davall and Sons, Ltd., at Greenford. After serving with Hordern-Richmond, Ltd., as technical assistant and chief draughtsman from 1938 to 1946, Mr. East held positions with Miles Aircraft, Ltd., de Havilland Propellers, Ltd., and Vickers-Armstrongs (Aircraft), Ltd.

* * *

A special six weeks' course is to be held at the Harwell Reactor School from June 3 to July 12, 1957, offering an opportunity to acquire basic knowledge of nuclear energy. It has been designed primarily for people of degree standard who are not directly concerned with overall reactor design. Some sixty places will be available and application forms are obtainable from the Reactor School, A.E.R.E., Harwell, Berks.

* * *

Mr. Frederick I. J. Page has been appointed manager of the aviation division of S. Smith and Sons (Australia) Pty., Ltd. He succeeds Mr. F. J. Shaw, who has been appointed assistant general manager to the Australian company. Mr. Page will initially be located at the Bank Street, South Melbourne, branch of S. Smith and Sons, but early in 1957 is to move to the company's headquarters at Granville, N.S.W.

* * *

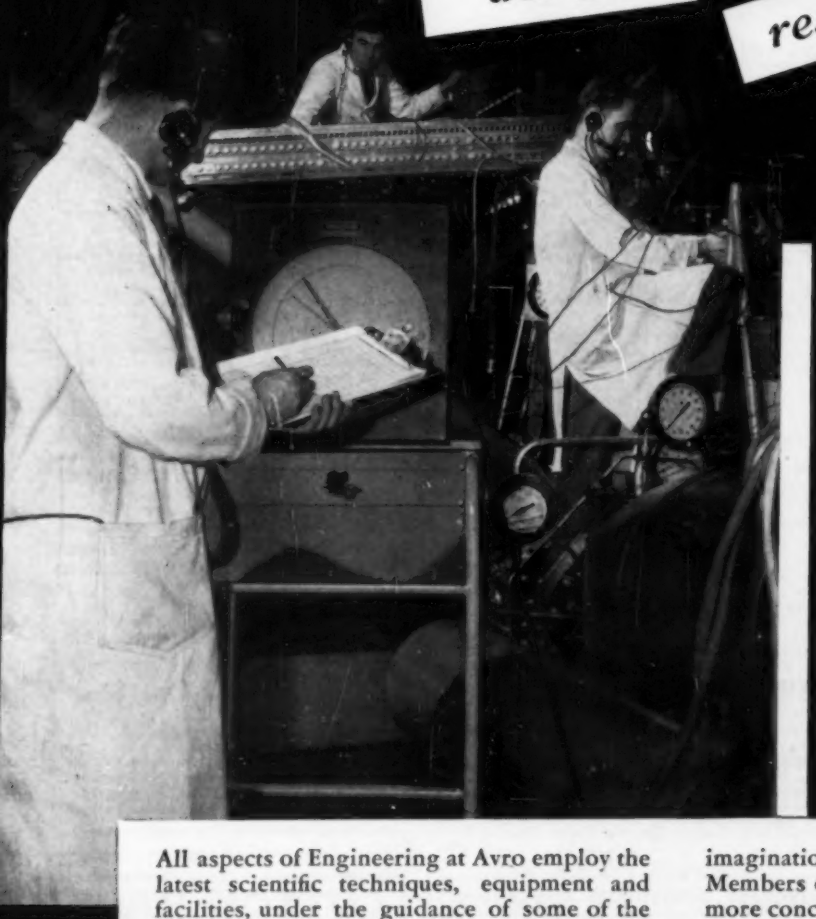
Among the occupants of an imposing new ten-storey building overlooking the Thames near Lambeth Bridge are Cementation (Muffelite), Ltd., well known as designers and constructors of test-house silencing equipment and—a recent development—shockproof mountings for aircraft instruments and machine tools. They are a subsidiary of the Cementation Co., Ltd., who are the sole lessees of the building and occupy the upper floors. The address is 20 Albert Embankment, London, S.E.11, and the telephone number is Reliance 6556.

Publisher's announcement: A printing error in the advertisement of the Middleton Sheet Metal Co., Ltd., on page 2 of the issue of December 14 may have led to misunderstanding. A statement on that page should have read ". . . resistance welding of high strength aluminium alloys by Middleton is proving its worth. Instead of the weight of 1,600 rivets, 1,600 spots of no weight whatsoever do the job on the navigator's table for the Avro Vulcan."

Technicians, Draftsmen and Professional Engineers:

advance with Avro

design *research* *development*



AVRO AIRCRAFT

OFFERS OPPORTUNITIES FOR THESE PEOPLE—WITH OR WITHOUT AERONAUTICAL EXPERIENCE:

Mathematicians
Computer Programmers
Aerodynamicists
Metallurgical Technicians
Stress Engineers • Systems Engineers • Mechanical Engineers
Flight Test Engineers
Controls Engineers
Aero Thermodynamicists
Vibration & Flutter Engineers

Civil Engineers for:
Structural Analysis, Tests, Design
Computing Specialists
Draftsmen & Technicians

All aspects of Engineering at Avro employ the latest scientific techniques, equipment and facilities, under the guidance of some of the world's finest technical and engineering talent.

Avro's broad, diversified range of advanced aeronautical design projects allows technical and engineering people unexcelled opportunities to utilize their ingenuity, initiative, imagination and creative abilities.

Members of Avro's compact design team have more concentrated job responsibility resulting in more recognition for individual ideas and accomplishments.

Write *today* for further information concerning *your* opportunities to work on design concepts at Avro which represent the most advanced state of your art.

TOM SHAW, EMPLOYMENT MANAGER

AVRO AIRCRAFT LIMITED

BOX 4004, TERMINAL 'A', TORONTO, CANADA

MEMBER: A. V. ROE CANADA LIMITED & THE HAWKER SIDDELEY GROUP

FLIGHT
and
AIRCRAFT ENGINEER

PRESS DAY — *Classified advertisement "copy" should reach Head Office by* FIRST POST THURSDAY *for publication in the following week's issue subject to space being available.*

CLASSIFIED ADVERTISEMENTS

Advertisement Rates. 5/- per line, minimum 10/-, average line contains 6-7 words. Special rates for Auctions, Contracts, Patents, Legal and Official Notices, Public Announcements, Public Appointments, Tenders 6/- per line, minimum 12/-. Each paragraph is charged separately, name and address must be counted. All advertisements must be strictly prepaid and should be addressed to FLIGHT Classified Advertisement Dept., Dorset House, Stamford Street, London, S.E.1.

Postal Orders and cheques sent in payment for advertisements should be made payable to Iliffe & Sons, Ltd., and crossed & Co.

Trade Advertisers who use these columns regularly are allowed a discount of 5% for 13, 10% for 26 and 15% for 52 consecutive insertion orders. Full particulars will be sent on application.

Box Numbers. For the convenience of private advertisers, Box Number facilities are available at an additional charge for 2 words plus 1/- extra to defray the cost of registration and postage, which must be added to the advertisement charge. Replies should be addressed to "Box 0000, c/o Flight," Dorset House, Stamford Street London, S.E.1.

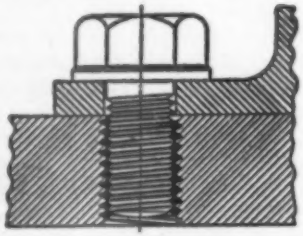
The Publishers retain the right to refuse or withdraw advertisements at their discretion and do not accept liability for delay in publication or for clerical or printer's errors although every care is taken to avoid mistakes.

Solder with LITESOL REGD. TRADE MARK
"PERMATIP"
AND
"PERMABIT"
INSTRUMENTS
FOR
GREATER
SOLDERING
EFFICIENCY

The soldering bit which maintains its face indefinitely without attention. 25 models available for mains or low voltage supply. Bit sizes 3/32 to 3/8 inch. Full details in booklet S.P.15 from sole manufacturers:—

LIGHT SOLDERING DEVELOPMENTS LTD
106 GEORGE STREET
CROYDON SURREY
Tel. CROydon 8589

WIRE
THREAD INSERTS



FOR NEW DESIGNS
AND SALVAGE
CROSS MFG. CO. (1938) LTD.
COMBE DOWN, BATH
TEL. COMBE DOWN 2355/6

AIRCRAFT FOR SALE

W. S. SHACKLETON LTD.

Europe's Leading Aircraft Brokers

offer

A MIXED BAG

WE doubt if anyone is seriously interested in business matters so soon after Christmas, but just in case . . .

WE have one exceptionally cheap light aircraft which would be an attractive hack for air racing; it is a Comper Swift, G-ABUU, iFtted with a Pobioy type R engine with 125 hours since complete overhaul. In store since 1954, it is offered for quick disposal at £165 as is ex Speeton.

OR perhaps you would rather have a helicopter. Three Sikorsky S.51s are available for immediate disposal. It would be nice to add one of these to the 138 different types of aircraft that we have sold. The helicopters are based at Croydon.

WE don't offer aircraft free of charge, but if you care to have a copy of our illustrated brochure, or a list of Chipmunk spares, please write.

W. S. SHACKLETON LTD., 175 Piccadilly, London, W.1. Cables: "Shackhud, London." Phone: HYDe Park 2448-9. [0070

R. K. DUNDAS

AEROPLANES BY DUNDAS

A Prosperous New Year to all our Clients

NEW Year Bargains:

PROCTOR IV. £125.

PROCTOR IV. £125.

PROCTOR IV. £195.

AEROPLANES BY DUNDAS

R. K. DUNDAS LTD., 59 St. James's Street, London, S.W.1. Tel.: HYDe Park 3717. Cables: "Dundas Aero," Piccy London. [0559

ROLLASON AIRCRAFT AND ENGINES, LTD., CRO. 5151. The Tiger Moth Specialists. [0130

MITCHELL AIRCRAFT LTD., have in stock one Auster V. and one Autocrat as well as a quantity of spares for various types of light aircraft. A few engines and propellers left.—Mitchell Aircraft, Ltd., Airport, Portsmouth. Tel. 1717641. [0348

VENDAIR of Croydon Airport offer from stock at Croydon: Long-range Proctor V, Proctor IV, and Proctor III; Auster Mark V; Auster Autocrat; Auster VD with Gipsy Major engine. Beechcraft Expeditor in first-class condition, complete with spares. Full details from Vendair, Croydon Airport, Croydon 5777. [0603

AIRCRAFT ACCESSORIES AND ENGINES

A. J.W. (INSTRUMENTS), LTD.

ALL types of aircraft instruments overhauled. Special test instruments made to your requirements. Particulars on request of our Magnetizer, Demagnetizer and Stroboflash—compact—efficient and inexpensive.

A. J.W. (Instruments), Ltd., Gatwick Airport, Horley, Surrey. Tel. Horley 1420 and 1510 (Ext. 38, 105/6). [0268

ROLLASON AIRCRAFT AND ENGINES LTD., CRO. 5151. For all Tiger Moth, Gipsy Major, Gipsy Queen and Gipsy Six spares. Specialists in the overhauling of Gipsy Engines. [0131

PHILLIPS & WHITE, LTD., offer from stock Instruments and instrument parts. Navigational equipment, electrical components, airframe parts and hydraulic components and parts. Engine spares for de Havilland Gipsy Major and Queen series, also Armstrong Siddeley Cheetah IX, X and XV spares. Stock lists available.—61, Queen's Gardens, London, W.2. Tel.: Ambassador 8651, 2764. Cables Gyrair, London. [0466

ANOTHER EXCLUSIVE OFFERING!

24 Passenger airline C-47s
Available for Immediate Sale
Immediate Delivery
In Foreign Scheduled Airline Operation
Price asking $110,000 F.A.F. Location
In excellent condition

For details contact: (Dept. F-E)
WILLIAM C. WOLD ASSOCIATES
(*Exclusive Sales Agents*)
551 Fifth Avenue, New York 17, N.Y.
Telephone: MUrray Hill 7-2050 *Cable:* BILLWOLD, N.Y.

SHORT AVIATION
for
D. H. RAPIDE SPARES
BRAND NEW—EX STOCK—IMMEDIATE DELIVERY
HIGHLY COMPETITIVE PRICES
TIGER MOTH SPARES
IN QUANTITY—EX STOCK—BRAND NEW—VERY LOW PRICES
R. A. SHORT AVIATION, WHYTELEAFE SURREY. PHONE: UPLANDS 8211/2

AEROSERVICES
LIMITED
Croydon Airport
Tel: CROydon 9373 *Cables: Aeroserv, Croydon.*
EXTEND TO THEIR CUSTOMERS BOTH AT HOME AND OVERSEAS EVERY WISH FOR A PROSPEROUS NEW YEAR

The . . .
British Air Line Pilots Association
95 MOUNT STREET, W.1.
Tel.: GROsvenor 6261
Membership open to all commercial and Service Pilots. For full details concerning objects and particulars of membership please write to Secretary.

COTTON BAGS
FOR SPARE PARTS, ETC.
WALTER H. FELTHAM & SON, LTD.
Imperial Works, Tower Bridge Road,
Telephone: HOP 1784 LONDON, S.E.1

AIRCRAFT SPRING WASHERS

TO B.S. SPECIFICATION S.P.47
CROSS MFG. CO. (1938) LTD., COMBE DOWN, BATH

AVIAKIT

¾ Length Sheepskin Lined Flying or Motoring Coat

No. 903

A warm and comfortable gaberdine coat, body lined throughout soft sheepskin. Deep luxurious beaver-lamb collar. Waterproof interlined throughout.

Sizes 34 to 44 chest, length 34"

Price: £6.19.6

Terms to Flying Clubs. Trade Supplied
Send 4d. in stamps for illustrated catalogue

Lewis LIMITED

(Dept. F.) 124 Great Portland Street, London, W.1

Tel. Museum 4314, Grams.: Aviakit, Wesdo, London.

TECHNICAL PUBLICATIONS

department of

SIR GEORGE GODFREY & PARTNERS Limited

have vacancies for

TECHNICAL ILLUSTRATOR, male or female for the preparation of line work to the standard required for A.P.'s and A.R.B. manuals.

TECHNICAL AUTHOR, male or female, preferably experienced in the preparation of A.P.'s and A.R.B. manuals; applicants with suitable R.A.F. or R.N. experience would be considered.

Write, giving full details of experience, age and salary required to the **Personnel Officer, Hampton Road West, Hanworth, Middx.**

AERIAL CAMERAS
ENGLISH and AMERICAN MAKES
ACCESSORIES
LENSES
FILMS AVAILABLE FROM STOCK
DEVELOPING TANKS

K19B, K20, F52, K24, F24, F25, K8AB, and other cameras, and accessories available from stock.

Write:—

Air Survey Dept.

Harringay Photo Supplies

423 Green Lanes - - London, N.4

Mon. 5241/2.

MINISTRY APPROVED COURSES FOR

COMMERCIAL PILOT — INSTRUMENT RATING

All subjects for professional licences and ratings, including Academic, Technical, simulated and practical flying. Home-Study excellent alternative.

- *Individual coaching.* - *Refresher Courses.*
- *Officially appointed by the Institute of Army Education for Forces Correspondence Scheme.*

Full details from your Station Education Officer, or

London School of Air Navigation Ltd.

33 Ovington Sq., Knightsbridge, London, S.W.3
KEN. 8121 *Flying Base: Croydon Airport*

AIRCRAFT SERVICING

REPAIRS and C. of A. overhaul for all types of aircraft.—Brooklands Aviation Ltd., Civil Repair Services, Sywell Aerodrome, Northampton. Tel.: Moulton 3218. [0307

CAPACITY AVAILABLE

KELLERING and profile milling in all metals. Send us your die blocks to copy from wood or plaster masters. Up to 5ft by 8ft max. size. We are die copiers to the trade.
ARMYTAGE BROS. (KNOTTINGLEY), LTD., The Foundry, Knottingley, Yorkshire. Tel.: Knottingley 2046. [0975

CLOTHING

R.A.F. officers' uniforms purchased; good selection of R.A.F. officers' kit for sale, new and reconditioned.—Fishers, Service Outfitters, 86-88 Wellington Street, Woolwich. Tel.: Woolwich 1055. [0567

CLUBS

SURREY Flying Club, Croydon Airport, M.C.A. approved for Private Pilots' Licences. Link trainer instruction available. Open seven days a week. Croydon 9126. [0292

HERTS. AND ESSEX AERO CLUB, Stapleford Tawney Aerodrome. M.C.A. approved private pilots' licence course. Auster, Gemini, Tiger, Hornet and Proctor aircraft. Trial lesson 35s. 15 miles centre of London. Central Line Underground to Theydon Bois, bus 250 to club. Open every day.—Tel.: Stapleford 210. [0230

EXETER AERO CLUB. Course approved for Private Pilot's Licence. Auster and Tiger Moth aircraft £3 7s. 6d. per hour, reduced solo rates for contract hours. Gemini and Messenger aircraft also available. Instructors' courses, charter flying, pleasure flights. Luxurious club house, squash court.—Exeter Airport. Tel.: Exeter 67433. [0343

CONSULTANTS

R. K. DUNDAS, LTD., have been giving the correct answer to aviation problems for twenty years. Technical. Purchasing Operations. Marketing. 59, St. James's Street, London, S.W.1. HYDe Park 3717. [0560

CONTACT LENSES

MODERN CONTACT LENSES CENTRE 7(D.1), Endsleigh Court, W.C.1. Deferred Terms. Booklet sent. [0342

ELECTROPLATING

HEADLAMP reflectors, heavily electroplated 100% silver guaranteed, 6/- each, mirror finish. Post and packing 1/3 each. Cork seals 6d. each. Re-posted day received.—Send with P.O. to R. E. Packer, 169, Hotwell Road, Bristol, 8. [0980

PACKING AND SHIPPING

R. AND J. PARK, LTD., 143/9 Fenchurch St., E.C. Tel.: Mansion House 3083. Official packers and shippers to the aircraft industry. [0012

TUITION

CIVIL PILOT/NAVIGATOR LICENCES

AVIGATION, LTD., provides full-time or intermittent instruction and postal tuition, or a combination of any of these methods to suit individual requirements for the above licences. Classroom instruction can be provided for A.R.B. General, certain Specific Types and Performance Schedule examinations. Link training Dept. at MONarch 1364.
FOR full details apply to The Principal,

AVIGATION, LIMITED

30 Central Chambers, Ealing B/way, London, W.5. Tel.: Ealing 8949. [0248

"I spy . . ."

The magic eyes of childhood

ENTRANCING EYES. They might well be the eyes of a child *you* love. If only one could be certain that blindness would not dim them. For each year, in Britain alone, some 12,000 people of all ages lose their sight.

It is then, when vision fails, that the R.N.I.B. stands ready with practical aid. A purely voluntary body, the R.N.I.B. serves the entire Blind Community—some 100,000 in all. Your contribution or tax-free legacy can help to maintain this vital work.

The Royal National Institute for the Blind, 224 Great Portland Street, London, W.1.

(*Registered under the National Assistance Act*, 1948).

R.N.I.B. SERVICES FOR THE BLIND

EDUCATIONAL

Nine Sunshine Home Nursery Schools. Worcester College for Blind Boys. Chorleywood College for Blind Girls. Condover Hall School for Blind Children with Additional Handicaps.

FOR THE NEWLY BLIND

Rehabilitation courses for adults at the three Queen Elizabeth Homes of Recovery.

HOMES AND HOSTELS

Thirteen Residential and Holiday Homes—*but more are needed.*

BRAILLE

Literature supplied at a *fraction of production cost;* Braille tools and appliances also subsidised.

TRAINING AND EMPLOYMENT

Physiotherapy and Commercial courses. Industrial training scheme. Placement Service continually seeks openings for the Blind.

AIDS AND APPLIANCES

Over 200 items, available to all the blind in U.K. at one-third production cost.

ROYAL N.I.B. WORKS FOR ALL BRITAIN'S BLIND

SPACE DONATED BY

Airline Air Spares Ltd.
Southend Airport
Southend-on-Sea

TUITION

AIR SERVICE TRAINING

The only fully equipped private School of Aviation. Specialist staff, comprehensive equipment and full residential and recreational facilities within the School ensures the soundest training for an aviation career.

M.T.C.A. APPROVED COURSES

for private and commercial pilots' licences and maintenance engineers' licences in categories "A" and "C."

HELICOPTER COURSES

for private and professional licences. Details available from the Commandant.

AIR SERVICE TRAINING, LTD.

Hamble, Southampton. Tel. Hamble, 3001/9. [0970

NIGHT Flying, instrument flying, commercial pilot licences. Approved M.T.C.A. private pilot's course.

EVERY facility at reasonable rates from

SOUTHEND - ON - SEA MUNICIPAL AIR CENTRE and FLYING SCHOOL, Municipal Airport, Southend-on-Sea. Rochford 56204. [0452

FREE. Brochure giving details of courses in all branches aero eng., covering A.F.R.Ae.S., M.C.A. exams., etc. Also courses for all other branches of engineering.—Write: E.M.I. Institutes, Dept. F.26, London, W.4. (Associated with H.M.V.). [0964

A.F.R.Ae.S., A.R.B. Certs., A.M.I.Mech.E., etc., on "no pass, no fee" terms. Over 95 per cent. successes. For details of exams and courses in all branches of aeronautical work, navigation, mechanical eng., etc., write for 144-page handbook free.—B.I.E.T. (Dept. 702), 10 Wright's Lane, London, W.8. [0707

LEARN to fly, £26; Instructor's Licences and Instrument flying for £3 5s. per hour. Night flying £4 5s. per hour. Residence 6 guineas weekly. Approved M.C.A. Private Pilot's Licence course. Specialized course for Commercial Pilots' Licence.—Wiltshire School of Flying, Ltd., Thruxton Aerodrome (Andover Junction 1 hour 15 minutes from Waterloo), Hants. [0253

A SUCCESSFUL career for your son. Aeronautical, Technical and practical training for all branches of aeronautical engineering. Diploma course leads to executive appointments in civil aviation design and development, draughtsmanship, maintenance, etc. Extended courses to prepare for A.F.R.Ae.S. and A.M.I.Mech.E. examinations. Write for prospectus to Engineer in Charge, College of Aeronautical Engineering, Chelsea, London, S.W.3. FLAxman 0021. [0019

MARSHALL

AIRPORT WORKS CAMBRIDGE

AIRCRAFT DESIGN OFFICE

require

SENIOR STRESSMEN for positions of responsibility. Long-term prospects. Salary commensurate with ability.

ELECTRICAL DESIGN ENGINEER for work on interesting projects. Good salary.

COMMERCIAL ARTIST required for Aircraft Drawing Office.

These appointments are superannuated and assistance with housing is given, if required, to suitable applicants.

Apply, in writing, giving full details of experience and convenient dates for interview, to the

PERSONNEL MANAGER

DESIGN TEAM

A.R.B. APPROVED

Aircraft Drafting and Stressing

Radio and Electrical Installation Design

WESTERN AIRWAYS LTD.

DESIGN OFFICE EXETER AIRPORT

PUBLIC ANNOUNCEMENTS

AIR TRANSPORT ADVISORY COUNCIL

THE AIR TRANSPORT COUNCIL give notice that they have received the undermentioned applications to operate scheduled air services:—

APPLICATION No. 998. From Transair Ltd., of Croydon Airport, Croydon, Surrey, for a seasonal Normal Scheduled Service with Dakota aircraft for the carriage of passengers, supplementary freight and mail between London (Croydon and/or Gatwick) and Tarbes (for Lourdes) at a frequency of up to 10 return flights weekly during the season from April to October each year for a period of 10 years from date of approval.

APPLICATION No. 40/6. From Airlines (Jersey) Ltd., of The Parade, St. Helier, Jersey, Channel Islands, for permission to operate Bristol 170 aircraft in addition to the aircraft types already authorised on all their U.K. Internal and Normal Scheduled Services for the remainder of the periods of approval, and where relevant to operate such aircraft from London Airport as well as from Croydon or Gatwick.

APPLICATION No. 439/1. From British European Airways Corporation, of Keyline House, Ruislip, Middlesex, for an amendment to the terms of approval of the Normal Scheduled Service which the Corporation have been authorised to operate on the route London - Milan - Athens, for the period up to 31st March, 1962, so as to extend the service to Istanbul, operating on the route London-Milan-Athens-Istanbul (optional).

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [6057

SITUATIONS VACANT

ASSISTANT Chief Stressman required by expanding organisation. Essential qualifications should include five years experience on the stress analysis of aircraft structures and mechanisms and a Degree or A.F.R.Ae.S. The position offers good prospects, superannuation scheme, excellent working conditions. Applications giving full particulars to be addressed to Chief Designer, Aero Controls, Ltd., Weedon Road, Northampton. [6051

MANAGEMENT TRAINEES

★

Large, expanding, light engineering Company in the South Midlands is prepared to engage a selected number of Young Men (23-30) for training through technical work, foremanship and on eventually to Managerial Posts. Qualifications required:

1. Secondary Grammar School Education.
2. H.N.C. standard in Mechanical Engineering.
3. Five-year apprenticeship in reputable engineering firm or equivalent experience.

Applicants must be prepared for factory hours during training (including nightshift if necessary) and to work hard for a number of years to fit themselves for the higher posts in engineering industry. Apply in own writing giving age, qualifications, present salary and career to date in chronological order.

Box No. 5090 c/o Flight.

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED

WEYBRIDGE

require the following personnel in the Civil Aircraft Servicing Department:

(x) **TECHNICAL LIAISON ENGINEERS** (Airframe and Electrical). Applicants should be well educated, including an apprenticeship or similar training, and have had some experience on aircraft design.

(y) **AIRCRAFT SERVICING ENGINEERS** (Airframe), with 'A' licences endorsed for Viking or four-engined aircraft; for representatives' work on Viscount aircraft overseas, after gaining the necessary experience at Weybridge.

(z) **TECHNICAL ASSISTANT** for dealing with defects statistics on aircraft. Applicants, such as ex. R.A.F. personnel, must have had some experience on the operating and maintenance of Civil and/or Military aircraft.

Applications, quoting date of advertisement and prefix letter 'x' 'y' or 'z' to:

EMPLOYMENT MANAGER,

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED,

WEYBRIDGE WORKS, WEYBRIDGE, SURREY.

A. V. ROE & CO., LTD.

AERONAUTICAL ENGINEERS

There are a number of vacancies in the Technical Publications Department for

TECHNICAL ARTISTS

Capable of preparing perspective drawings, exploded drawings, layout and photographic retouching, etc., for aircraft manuals, spare parts schedules, repair schemes and sales brochures.

TECHNICAL AUTHORS

For the preparation of descriptive and servicing manuals, servicing schedules, pilots' notes, etc. Candidates should have had experience of aircraft servicing and maintenance and special consideration will be given to ex-R.A.F. personnel.

SPARES SCHEDULE COMPILERS

For compilation of aircraft spares schedules and assessing spares required for aircraft maintenance. Applications are invited from persons having experience of this type of work or long experience of aircraft maintenance.

DRAUGHTSMEN

For work on the design of ancillary and all ground equipment necessary for servicing the aircraft.

APPLICATIONS SHOULD BE MADE, quoting Reference TECH. PUBS./R.166/F, to

The Personnel Manager,
A. V. Roe & Co., Limited,
Greengate, Middleton, Manchester.

VICKERS-ARMSTRONGS (Aircraft) LIMITED

WEYBRIDGE

require

AIRFRAME FITTERS AND AIRCRAFT ELECTRICIANS

with experience on civil or military aircraft, to assist on flight test and development work at Wisley Airfield (near Ripley, on the main London/Guildford road) on fighter aircraft.

Applications, quoting date of advertisement and prefix letter (a) should be made to:

Employment Manager,
Vickers-Armstrongs (Aircraft) Limited,
Weybridge Works,
Weybridge, Surrey

Back issues Flight 1909—1956 available, also hundreds other books, magazines. We buy sell or exchange aero books. Open all day Saturday only. Or write:

BEAUMONT AVIATION LITERATURE
2a RIDGE AVENUE, LONDON, N21

SITUATIONS VACANT

HUNTING PERCIVAL AIRCRAFT LIMITED

require all grades of

DRAUGHTSMEN, AERODYNAMICISTS and LABORATORY ASSISTANTS

for work on several new and interesting projects, at both their Luton and London offices.

EXCELLENT working conditions, in new offices. Good salaries and prospects.

CONTRIBUTORY Pension and Life Assurance Scheme. Interviews can be arranged in Luton or London, either during the week, or on Saturdays.

APPLICATIONS, stating locality preferred, giving full details of qualifications, experience, age and salary required, and quoting ref A/6, should be addressed to:

The Personnel Manager,
HUNTING PERCIVAL AIRCRAFT LIMITED
The Airport,
LUTON,
Beds. [6050

---

1 DAKOTA A and C Licensed Engineer to be Base Engineer, Blackbushe.

FLIGHT Engineers licensed in categories A and C for York and/or Dakota Aircraft.

ENGINE and Airframe Fitters with York and Dakota experience. 1 X Licensed Instrument Fitter. Good salaries paid in accordance with experience.

APPLY:

Chief Engineer,
DAN-AIR ENGINEERING, LTD.,
Lasham Airfield,
Hants. [6047

DEVELOPMENT ENGINEERS and PHYSICISTS

DEVELOPMENT Engineers and Physicists (Senior and Junior) are required by Louis Newmark, Ltd., for its expanding Laboratories at New Addington, Surrey. The work includes the design and development of electro mechanical devices used in aircraft control systems and covers all stages up to final installation and testing in aircraft. Experience of pressure capsule and servo following equipment an advantage. Applications from suitable ex-R.A.F. technical personnel are welcomed. Pension Scheme.—Apply in writing giving full particulars to Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon. [6052

DESIGN SECTION LEADERS

ARE required by an aircraft company near London for the design of structures and mechanical equipment.

APPLICANTS must hold H.N.C. or similar qualification and have had a minimum of five years experience on the design of aircraft structures and mechanisms.

GOOD salaries will be paid according to qualifications and experience, together with first-class prospects of advancement.

APPLICATIONS should be addressed to Box No. 5790, giving full details of qualifications, experience, age and salary required. [6056

PRESS RELATIONS OFFICER/PILOT

A LARGE company of aircraft accessory manufacturers require a young man with Press relations or general writing experience, who is also a qualified and experienced pilot. Although his main duties will be connected with Press relations in a particularly interesting field of aviation, there will be opportunities to fly for the company in single-engined aircraft, on test and communications work.—Apply Box No. 5745. [6048

TEST and Laboratory Engineers required for gyro and electro mechanical instruments. Apply stating age, experience and salary required to S. G. Brown, Ltd., Shakespeare Street, Watford, Herts. [0147

AN Assistant Flying Control Officer required for Airfield in the West of England. G.C.A. or Airfield Radar experience essential.—Write giving details of age and previous experience, etc. to Box No. 5776. [6053

AIRCRAFT Stressmen required by expanding organisation in Manchester area. Salaries will be high and in line with age, experience and qualifications. Pension scheme is available. Please apply with full particulars, quoting reference WEST to Box 5793. [6058

SCOTTISH AIRLINES (PRESTWICK), LTD., require a Maintenance Engineer holding "A" and "C" licences endorsed for Avro York and R.R. Merlin 500, for their overseas base Malta. Good pay and allowances, superannuation scheme.—Write in first instance to: Chief Engineer, Scottish Airlines, Stansted Airport, Essex. [6055

THE HESTON AIRCRAFT CO. LTD.

HESTON AIRPORT, Hounslow, Middlesex

have immediate openings in their

DESIGN OFFICE

on a new and interesting **Civil Aeroplane** for:

SENIOR, INTERMEDIATE and JUNIOR DRAUGHTSMEN

EXPERIENCED STRESSMEN

LOFTSMEN

Long-Term Programme
Good opportunities

Please write with full particulars to:
THE CHIEF DESIGNER

A. V. ROE & COMPANY LTD.

have one or two vacancies for

SENIOR AIRCRAFT STRESSMEN

These positions offer the opportunity of working on Britain's most advanced Supersonic Aircraft.

Candidates should possess a senior Mechanical or Aeronautical Engineering Degree or equivalent, and not less than three years previous experience.

Individual salaries will be arranged in accordance with the qualifications of the applicant.

Apply quoting full particulars and Ref: A/C/R175/S.S/F to:

The Chief Designer
A. V. ROE & CO., LTD.
Greengate
Middleton
Manchester

SITUATIONS VACANT

WANTED. Ignition Licensed Engineer (working), to run small Magneto Shop.—Apply: Staravia, Blackbushe Airport, Camberley, Surrey. [6049

AN Air Traffic Control Officer is required by Hawker Aircraft Limited at Dunsfold Aerodrome, Surrey, operating single engine and military aircraft. Applicants must have R.A.F. or M.C.A. Certificates. Please write fully to The Personnel Supervisor, Hawker Aircraft Limited, Canbury Park Road, Kingston-on-Thames, Surrey. [6055

A. C. COSSOR LTD., require a Technical Sales Engineer for radar duties. Successful applicant will be based in North London but must be prepared to travel within the U.K. and overseas for liaison duties. Good general radio/radar technical background essential. Operational and technical knowledge of Gee and airborne radar desirable. Pension scheme. Write giving details of education, qualifications and experience, etc., to the Technical Director, A. C. Cossor Ltd., Highbury Grove, London, N.5. [6054

BOOKS, ETC., WANTED

COLLECTOR requires "Flight" 1909 to 1923 inclusive and any Janes Aircraft or Fighting Ships prior 1939. Please state prices.—Box 5775. [6054

BOOKS, ETC.

"CASH From Your Camera," by Arthur Nettleton, F.R.G.S. Shows how amateur photography can be made to pay for itself by the sale of pictures to newspapers, magazines, calendar publishers, etc., and deals with the many problems involved. 2nd Edition. 7s. 6d. net from all booksellers. 8s. 0d. by post from Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S.E.1.

SAUNDERS-ROE LTD.

require

SENIOR

AERODYNAMICISTS

STRESS ENGINEERS

DRAUGHTSMEN

and other Technicians at their London and Osborne, I.o.W., design offices.

Qualified design engineers—resourceful men of original thinking and mature engineering judgement—who can meet the challenge of new problems, owe it to themselves to investigate the career opportunities now available in our organisation.

We can offer pleasant working conditions, salaries commensurate with ability, and assistance with accommodation for candidates selected to work at Osborne.

★ **Those interested should apply, quoting age, experience, qualifications and ref. F/10 to the Personnel Officer, Saunders-Roe Ltd., East Cowes, I.o.W.**

SENIOR AIRCRAFT INSPECTOR

Magnesium Elektron Limited require an inspector of advanced status and considerable experience of aircraft inspection work. Experience with light alloy welded components and structures is essential. Candidates must have administrative ability and be able to organise as well as conduct inspection of prototype and development projects. Salary for this staff appointment will be commensurate with qualifications and experience. Contributory pension scheme.

Written applications, quoting reference SF2 and full details, to

Personnel Officer (Staff), Magnesium Elektron, Limited, Clifton Junction Swinton, near Manchester.

A. V. ROE & CO., LIMITED

WEAPONS RESEARCH DIVISION

TRIALS DEPARTMENT,

WOODFORD, CHESHIRE

Applications are invited for the following posts in our Guided Weapon Trials Department.

1. **ENGINEERS** to undertake preparation of servo systems in the trials phase.
2. **ENGINEERS** to undertake design and development work of telemetry and monitoring systems.
3. **TECHNICIANS,** mechanical and electronic, for work in development and trials groups.
4. **DRAUGHTSMEN,** general mechanical and/or electronic, for work in telemetry installations and test rigs.

Qualifications and Experience

For positions 1 and 2. H.N.C. or equivalent is desirable, together with some appropriate experience.

For positions 3 and 4. O.N.C. would be desirable, but is not essential if the applicant has suitable experience.

Successful applicants will work in modern laboratories situated in a pleasant rural area in Cheshire.

The posts are permanent and pensionable.

Applications, giving full details of age, qualifications and experience, should be addressed, quoting reference WRD/TRIALS/R.173/F, to:

The Personnel Manager,
A. V. Roe & Co., Limited,
Greengate, Middleton, Manchester.

BOOKS, ETC.

"MECHANICS for the Home Student," by Eric N. Simons, in association with W. D. Burnet, B.Eng., Lecturer in Mechanical Engineering at Sheffield University. The nineteen chapters of this practical book provide an excellent introduction to the subject under such headings as action, force, momentum, power, applied force, friction, centre of gravity, density, fluids, gases, heat, vibration, stress, impact, rotation, etc. 7s. 6d. net from all booksellers. By post 8s. 1d. from Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S.E.1.

"PLASTICS Progress: Papers and Discussions at British Plastics Convention 1955." The complete text and illustration of the papers (given by 29 experts) together with a full report of the discussion. Subjects include: unplasticized p.v.c.; plastics materials developments; reinforced plastics; durability and performance of plastics in service; problems in injection moulding; economics of large mouldings; new uses in industry—cables, metallization, footwear and conveyor belting. 50s. net from all booksellers. By post 51s. 8d. from Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S.E.1.

"ABACS or Nomograms," by A. Giet. Translated from the French by H. D. Phippon and J. W. Head. Most engineers have made use of nomograms at some time in their careers, and are fully alive to the fact that they are a very convenient tool when the same formula has to be solved repeatedly for several sets of variables. It is fair to say, however, that only a small proportion of even those who habitually employ nomograms know how to construct them for their own use. Most of the comparatively small literature on the subject is written for mathematicians and is extremely difficult for the practical engineer to comprehend. This book is essentially practical, and not only demonstrates the many and varied applications of the abac or nomogram, but shows how even those without highly specialized mathematical knowledge may construct their own charts. 35s. 0d. net from all booksellers. By post 35s. 10d. from the publishers: Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E.1.

BROOKLANDS AVIATION LTD.

NORTHAMPTON

require

SENIOR INSPECTORS

for work on

VALETTA and VARSITY AIRCRAFT

Regular work and Overtime

APPLY TO:

BROOKLANDS AVIATION LTD.

Buttocks Booth, Moulton, Northampton

INDEX TO ADVERTISERS

	Page
Aeroservices, Ltd.	16
Airline Air Spares, Ltd.	17
Avro Aircraft, Ltd.	15
Beaumont	19
Bellman Hangars, Ltd.	7
Birkett, Billington and Newton Ltd., T. M.	4
Blackburn and General Aircraft, Ltd.	Cover i
Boulton Paul Aircraft, Ltd.	3
Box No. 5090	18
B.P. Aviation Service	10
Bristol Aero-Engines, Ltd.	Cover iv
British Air Line Pilots Association, The	16
Brooklands Aviation, Ltd.	20
Cross Manufacturing Co. (1938), Ltd.	14
"Electronic and Radio Engineer"	5
Fairey Aviation Co., Ltd., The	11
Feltham and Son, Ltd., Walter H.	16
Firth-Vickers Stainless Steels, Ltd.	Cover ii
Godfrey and Partners, Ltd., Sir George	17
Harringay Photo Supplies	17
Heston Aircraft Co., Ltd.	19
Iliffe and Sons, Ltd.	5, 6
Latex Upholstery, Ltd.	6
Lewis, Ltd., D.	17
Light Soldering Developments, Ltd.	16
London School of Air Navigation	17
Magnesium Elektron, Ltd.	20
Marshall's Flying School, Ltd.	18
Martin-Baker Aircraft, Ltd.	14
Munro, Ltd., R. W.	6
Opperman, Ltd., S. E.	1
Roe and Co., Ltd., A. V.	19, 20
Rolls-Royce, Ltd.	9
Rotol, Ltd.	8
Saunders-Roe, Ltd.	20
Saunders Valve Co., Ltd.	6
Shell-Mex and B.P., Ltd.	12
Short Aviation, R. A.	16
Société Nationale de Constructions Aeronautiques du Nord	13
Teddington Aircraft Controls, Ltd.	2
Triplex Safety Glass Co., Ltd.	4
Vaughan and Co., Ltd., Edgar	2
Vernons Industries, Ltd.	Cover iii
Vickers-Armstrongs (Aircraft), Ltd.	18, 19
Western Airways, Ltd.	18
Wilson and Sons (London), Ltd., W.	7
Wold Associates, William C.	16

Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1, by SUN PRINTERS LTD., London, and Watford, Herts. *Flight* can be obtained abroad from the following: AUSTRALIA AND NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service, Ltd., Gordon & Gotch, Ltd. SOUTH AFRICA: Central News Agency, Ltd.; Wm. Dawson & Sons (S.A.), Ltd. UNITED STATES: The International News Co. Entered as Second Class Matter at the New York, U.S.A., Post Office.

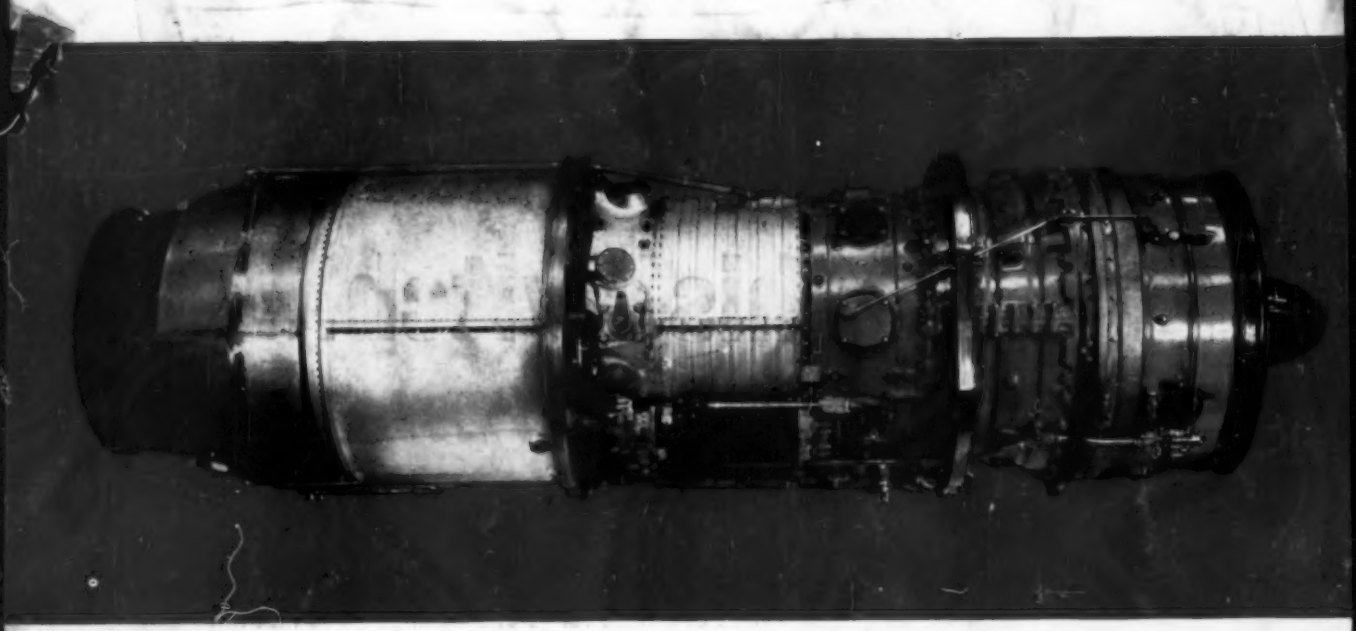
28 or 112 Volts at the turn of this switch..!

Incorporated in the ground power unit illustrated —one of a wide range of special-purpose machines developed by Vernons Industries—is a small selector switch, mounted on the panel, which controls the alternative output of 28 or 112 Volts. The unit includes a 6-Cylinder Rolls Royce engine driving the dual voltage generator specially developed by Vernons. The unit embodies comprehensive safety devices. *(Patent No. 732169)*

VERNONS
INDUSTRIES OF
LIVERPOOL

Are also specialists in design and manufacture of A.C. Ground Servicing Sets at 400, 1,600, or 2,400 Cycles.

VERNONS INDUSTRIES LIMITED · KIRKBY INDUSTRIAL ESTATE · LIVERPOOL TEL: SIMONSWOOD 3261



NEW BRISTOL OLYMPUS GIVES 16,000 LB THRUST WITHOUT REHEAT

The latest announced version of the Olympus, the B.Ol.6, is officially rated at 16,000 lb thrust without reheat. This makes it the most powerful turbojet for which figures have yet been released.

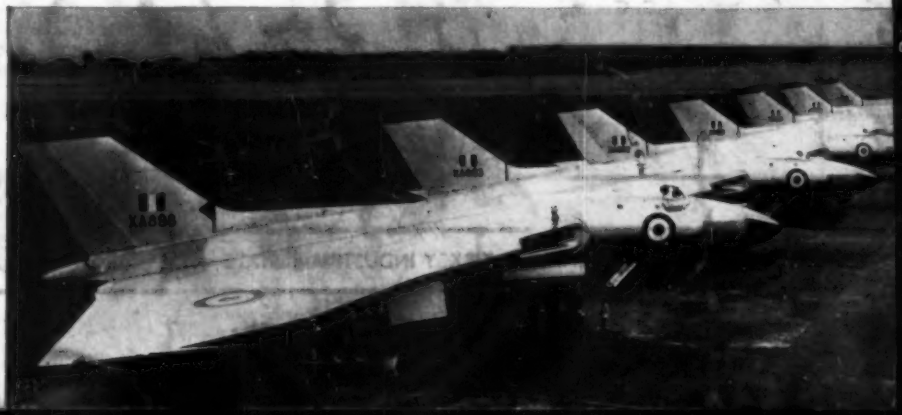
New versions of the Olympus under development will produce even greater thrust, emphasizing the fact that the Olympus has the greatest development potential of any engine of its class.

Low fuel consumption, high power at high altitudes —these are the basic advantages of the Olympus range, made possible by the twin-spool principle.

Olympus engines now in quantity production, deliver 12,000 lb thrust. Civil versions are available to the world's operators.

BRISTOL
Olympus

BRISTOL AERO-ENGINES LIMITED



Avro Vulcan B1 bombers, for R.A.F. Bomber Command, are powered by Bristol Olympus engines.